ment of the Army

ARMY RD&A BULLETIN

JANUARY - FEBRUARY 1992

TOTAL QUALITY MANAGEMENT...

...BEYOND THE BUZZWORD

JANUARY-FEBRUARY 1992
PB 70-92-1

Army RD&A Bulletin (ISSN 0892-8657) is published bimonthly by the Army Acquisition Corps Proponency Office. Articles reflect views of the authors and should not be interpreted as official opinion of the Department of the Army or any branch, command, or agency of the Army. The purpose is to instruct members of the RD&A community relative to RD&A processes, procedures, techniques and management philosophy and to disseminate other information pertinent to the professional development of the RD&A community. Private subscriptions and rates are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 or (202) 783-3238. Second class official postage paid at Alexandria, VA and additional offices. POSTMASTER: Send address changes to Editor, *Army RD&A Bulletin,* 5001 Eisenhower Avenue, Alexandria, VA 22333-0001. Articles may be reprinted if credit is given to *Army RD&A Bulletin* and the author. Unless otherwise indicated, all photographs are from U.S. Army sources. Approved for public release; Distribution is unlimited.

This medium is approved for the official dissemination of material designed to keep individuals within the Army knowledgeable of current and emerging developments within their areas of expertise for the purpose of enhancing their professional development.

By Order of the Secretary of the Army:
GORDON R. SULLIVAN
General, United States Army
Chief of Staff

Official:
MILTON H. HAMILTON
Administrative Assistant to the Secretary of the Army
00458

ARMY RD&A BULLETIN

Research Development Acquisition

Professional Bulletin of the RD&A Community

FEATURES

DEPARTMENTS

COVER

Featured in this issue is a perspective on Total Quality Management which emphasizes that TQM is not a destination but a journey to the future—a future of our own making.

TQM: BEYOND THE BUZZWORD

Not a Destination But a Journey to the Future

By LTC Kenneth H. Rose

Introduction

Total Quality Management. The term almost bludgeons us with its omnipresence and promise of a better tomorrow. Open any of the defense-related glossies and you are likely to find a full-page proclamation in the vein of "XLCORP: Your Total Quality Company." Military organizations of every size are sprouting committees and steering committees charged with "making it happen." Yet, trouble looms large on the not-too-distant horizon. There is great danger that over use and superficial understanding will relegate the term to little more than a buzzword to be sprinkled about like magic dust in staff meetings and contract proposals. The key to avoiding this lies in answering two obvious, but not-so-simple questions: What is it?, and What does it mean?

Total Quality Management is a paradox. It is new, but not new. Tracing its history is rather like viewing one of those evolution trees in a high school biology book—the ones that show protozoa at the roots of the tree and modern man somewhere high up in the branches, with aardvarks on one side and zebras on the other. The path is complicated by the use of multiple names for the same things. "Total Quality," "Total Quality Control," and "Total Quality Leadership" have all been used by different people. One of its principal spokesmen manages to avoid using any kind of label and simply refers to quality and productivity.

The roots of Total Quality Management lie in the work of 19th-century efficiency expert Frederick Taylor. His contribution, summed up in one sentence was: If you want to improve what you do, take a close look at how you do it. This provided the essential break from longstanding tradition: If you want to make the boat go faster, whip the oarsmen harder.

Statistical Process Control

The next step forward occurred near the end of World War I when Walter Shewart, a Bell Laboratories physicist, was given the task of designing a radio headset for military use. In establishing design parameters from anthropometric data, he observed that differences in human head breadth—the distance between the ears—seemed to be normally distributed; that is, they followed the famous bell-shaped curve. He wondered if this phenomena might be present in man-made processes as well, particularly those associated with the manufacturing work of his employer. After considerable study, he concluded that almost all types of repeatable activity, either manufacturing or administrative, exhibited this property of variation. He developed a system of measuring variation called "statistical process control (SPC)."

During World War II, the demand for materiel went far beyond anything experienced before. Poor quality was no longer just a business expense, it could affect national survival. The War Department hired W. Edwards Deming, a Shewart student and researcher at the Census Bureau, to teach statistical process control methods to the U.S. defense industry. The effort was a great success—and deemed so critical that the techniques were classified as military secrets.

After the war, interest in the SPC methods that had been so successful inexplicably waned. American industry chose a path of quality control and quality assurance that was dependent upon inspection at the end of the process or production line. Defective items were either discarded or sent back to be redone.

Meanwhile, Deming was invited to Japan by U.S. occupation forces to assist with the postwar census. While there, Japanese scientists and engineers asked him to present a few lectures on SPC. Joseph Juran and Armand Feigenbaum, other American quality experts, also visited Japan. Japanese engineers studying U.S. literature discovered a 1931 text by Shewart. The result of all of this was a dramatic difference in the approach to quality in Japan. They institutionalized the following chain reaction: Improve quality, decrease costs, improve productivity, capture markets, stay in business, provide more jobs. Quality was no longer just another expense in the manufacturing process; it became a way of life.

So, after all this, what exactly is Total Quality Management? Air Force General Ronald W. Yates, speaking at the 2d

National TQM Symposium in November 1990, proposed that it is a "leadership philosophy." It may be, but then so is Zero Defects and Whip The Oarsmen Harder. What is it about Total Quality Management that makes it any different from other leadership philosophies? Before answering that, it is important to point out that General Yates' view resolves a potential misunderstanding. Total Quality Management is about *management* and applies globally across the full length and breadth of an organization. It is not just about managing quality; it is not something that can be assigned to a special projects office and ignored until the next staff meeting. It is something new—something different. What makes it different is its focus on variation, customers, and continuous improvement.

Quality experts estimate that 85 percent of process variation is due to common cause and the remaining 15 percent is due to special cause.

Except for Boolean algebra and a lot of electrical switches, we do not live in a world ruled by one-zero, on-off, or yes-no choices. We live in a world of variation where shades of gray vastly outnumber simple black-white options. What Shewart discovered was a sense of order in that variation. Given almost any administrative or production process, a sample set of the output will exhibit a certain average value with all the actual values balanced above and below, the number of values decreasing as distance from the average increases.

For example, consider the output of an Army contracting office. Suppose that 25 contracts were selected at random and analyzed. Suppose further that the mean time-to-award was 60 days. Through basic statistical analysis, we compute the standard deviation (referred to as "sigma") for this set of contracts to be five days. We may then reasonably assume that about 99.7 percent of the contracts will have been awarded in 45-75 days, 95 percent in 50-70 days, and 68 percent in 55-65 days by moving three, two and one sigma above and below the mean. This data is used to determine if the process in operating in a controlled manner. The points three sigma above and below the mean are considered the "upper control limit" and "lower control limit" respectively. As long as individual contracts are awarded within these boundaries, 45-75 days, the contract award process is considered to be under "statistical control."

There is a second point here, though. The process may be under control, but may not deliver what is needed. Suppose that 45 days are required to transfer funds for contractual obligation. Any award before 45 days will not be supported by funds and will, therefore, be a violation of the law. Suppose also that higher headquarters has a policy that any funds on hand after 75 days will be withdrawn. Again, any award after that point is a problem. These two constraints constitute tolerances of the system. A process is considered "capable" if, as in this case, the statistical control limits, plus or minus three sigma, lie within established tolerances. If the tolerances in this example were changed to 50 and 60 days, the process would still be under statistical control, but no longer capable. To regain capability, the process must be improved to a level where the statistical control limits again lie within established tolerances.

In this nice, neat example all seems well. The office manager may like to see all awards accomplished in 60 days, but should not be unhappy with any awards made between 45-75 days. Any variation within the control limits is considered "common cause" variation—it is part of the process. However, the office manager should probably get excited if contract awards begin to come in beyond 75 days. Variation outside the control limits is considered "special cause" variation and can not be accepted as part of the normal process. This kind of variation is an indicator that something is wrong—that the process is no longer under statistical control.

Process Variation

Quality experts estimate that 85 percent of process variation is due to common cause and the remaining 15 percent is due to special cause. They further agree that the responsibility for common cause variation lies with management and that responsibility for special cause variation lies with other supervisors and, perhaps, workers.

Variation, the first main theme of Total Quality Management, may be summarized as follows:

- Accept and understand variation as a natural part of a process.
- Use statistical techniques to determine if variation is normal or erratic.

• Work on the process (management) or aberrations of the process (supervisors/workers) to reduce variation, as appropriate.

Customers

Customers are the next critical component of Total Quality Management. They exist on two levels: internal and external. External customers are usually obvious and easy to identify. Internal customers are less obvious, but often far more important to the process. Satisfying internal customers is the key to controlling variation. It is they who define the process tolerances.

As an example, suppose we are in a program management office dedicated to developing a new machine gun. Among the external customers, of course, are the soldiers in the field who will eventually use the weapons. Their concerns are practical and generally performance-related. Such issues include rate of fire, frequency of failure or malfunction, range, ease of maintenance, and, perhaps, weight. Their leaders have different user concerns, such as commonality of ammunition, repair parts, and skills required for repair. And their leaders have still other user concerns: transportability, climatic constraints, effect on ammunition consumption rates, and performance versus unit of issue.

Another group of external customers resides in the combat developments community. Materiel solutions must respond to the requirements documents prepared by this group. If they don't, user support vanishes and the program meets an abrupt end. The relationship with this customer points out a key element of Total Quality Management; that is, everyone is both a supplier and a customer. In this case, it is a bidirectional loop. While the combat developer is considered a customer of the program manager in materiel development matters, the program management office and its predecessors in the materiel development community are considered customers of the combat developers in the preparation of requirements documents.

This kind of relationship exists between government and industry. It was the subject of General Yates's address to the Second National TQM Symposium, mentioned earlier. Since the government has the money, it is easy to view the government as the customer in the acquisition process. However, when, as commander of the Air Force Systems Command, he asked leaders of industry what bothered them most, the number one reply was, "The request for proposal (RFP) process." The government may be the ultimate buyer, but when preparing an RFP, industry is the customer. Taking this new view allowed the Air Force Systems Command to make significant improvements in the RFP process, which, in turn, improved the overall acquisition process.

The concept of continuous improvement is perhaps the capstone of Total Quality Management

Finally, the U.S. Congress may be the ultimate external customer. More than one acquisition program has died in committee for lack of Congressional support. In this case, it is more practical than proverbial that "the customer is always right."

Internal customers are less apparent. They tend to be viewed as coworkers or other members of the team. In fact, processes are usually part of a complex network of generally lateral linkage between elements that are both customer of some other element and supplier to yet another. The group that prepares the technical specifications is a customer of the group that coordinates preparation of the requirements document with the user, and a supplier to the group that prepares the engineering specifications for the technical data package. The contracting office is a customer of the engineering group and others, such as acquisition strategy writers and integrated logistics managers who are part of similar customer chains. And, all of these groups are customers of the office administrator who keeps the lights on, the telephones working, and the copier running.

It is important to identify and understand these cooperating networks because another key characteristic of Total Quality Management is that the quality of individual products is determined by the degree to which that product meets the needs of the next customer down the line. Quality is not determined by desire or directive. Each internal customer places demands on its suppliers and must, in turn, meet the demands of its customers. These demands act as process tolerances and are the basis for controlling variation. Accordingly, they are the fundamental determinants of ultimate product quality.

These customer-supplier relationships are not naturally occurring events—at least not yet. They begin with a deliberate effort to identify just who the customers, internal and external, really are. Next, communication with customers must be initiated, executed, and most importantly, acted upon. Members of the process team must be oriented toward customer service, not process for process's sake. All of this should be accomplished in a proactive mode that makes the customer a part of the process team in so far as possible.

But, the customer service approach should not view customer satisfaction as a goal or an end in itself. Satisfied customers only define quality in a current context. They serve as a starting point for quality improvement. Quality is not a matter of "good enough," it is a matter of "how good can it be?"

Customer Orientation

Customer orientation, the second main theme of Total Quality

Management, is summarized below:

- A process comprises a broad network of elements, interrelated on a supplier-customer basis. Generally, each element is both a customer and a supplier.
- Under Total Quality Management, quality is determined by customer requirements and expectations, not organizationally-directed tolerances and standards.
- Customer satisfaction is the beginning, not the end of quality improvement.

Continuous Improvement

The concept of continuous improvement is perhaps the capstone of Total Quality Management. Unlike variation and customers, it is a mission—something to do. There is a vast array of tools available to do the job: pareto charts, fishbone diagrams, X-bar and R charts, and a number of other things deliberately avoided in the discussion to this point. These are all provided by a variety of sources from commercial texts to consulting groups that have sprung up around every borough and beltway across the nation.

The essence of continuous improvement lies in management's commitment to do it, and do it over the long haul. It flies in the face of near-term profit or achievement, so essential to stockholders and performance appraisals. It runs head-on into the traditional wisdom that higher quality means higher costs. But, just as management is responsible for common cause variation, management is responsible for continuous improvement. The Total Quality Management environment is simply not one in which everything would be all right if only those darned workers would do their jobs better.

Commitment must take the form of personal, direct involvement, not hands-off observation. This is probably why Total Quality Management was defined as a "leadership philosophy" earlier. Leaders who select a favorite subordinate, apply a title like "TQM Advisor," and then wait for quality to happen are wishing upon rainbows. Quality improvement is hard work. It must be nurtured from the top down. Any other approach will generate a, "Why bother?" response from the work force—a guaranteed fatal disease.

Shewart provided a road map for continuous improvement that has become classic in the sense that it has withstood the test of time. His Plan-Do-Check-Act cycle is almost universal in its acceptance and application. It is really just a restatement of the scientific method in process terms, but it is difficult to minimize its value with a qualifier such as "just." This approach has had wide and significant impact in replacing gut feelings with objective analysis. Quality Function Deployment is another approach that leaders may apply as a guide. The House of Quality is a matrix often used to aid analysis. These, and more, are fully discussed in most texts.

Unfortunately, there is much that mitigates against continuous improvement. Consider just a few aspects of the current culture, as revealed by common expressions.

"If it ain't broke, don't fix it." This little tidbit is almost as popular as it is regrettable. It sprang into being some years ago as good advice to those who would irresponsibly tamper with things that were working well at the expense of things that really needed attention. Of late, it has become an excuse, even a mandate, for complacency. A correct restatement would be, "If it ain't broke, what can we do to make it better?"

"Live with it." (soldiers, take note.) In a system characterized by brief assignments and unforgiving retribution for even the perception of a misstep, there is great temptation to avoid improvement actions that may be time-consuming or risky. The unpredictable cost of this approach is that on some future battlefield, some soldier may die with it, as well.

"We've always done it that way." (civilian employees, take note.) There is great comfort and security in following established procedures—and considerable social support for abiding by The Ways. The drawback is in the counter note, "If you do what you've always done, you'll get what you've always got." Not exactly the path of quality improvement.

Cultural Change

All of this underscores another key element of Total Quality Management: it requires cultural change. It is not business as usual; it is not old business, new name. It is different. The usually assumed roadblock is that people resist change. Maybe, maybe not. The Total Quality Management approach is that people do not resist change so much as they resist being changed by outside forces. Teamwork is the solution. Cast off the authoritarian hierarchies and bring people together to improve quality. Leaders, managers, supervisors, workers, customers, suppliers—all have a role in determining quality. All deserve an opportunity to make it better.

A summary of continuous improvement, then, is:

- Quality improvement is a management responsibility; it requires management commitment to initiate and sustain it.
- The Plan-Do-Check-Act cycle is a proven paradigm for continuous quality improvement.
- Continuous quality improvement requires a cultural change.

Conclusion

Total Quality Management. What is it? It is a leadership philosophy. What does it mean? It means quality improvement for an organization and its products or services. There are no checklists or cookbook solutions. It requires comprehensive understanding of what we do, why we do it, and how we do it. It requires extensive coordination and cooperation among participants, all driven by a constancy of purpose for ever-improving quality. While the road is not easy, it is an important one to choose. And, it is important to remember that Total Quality Management is not a destination, but rather a journey—a journey to the future that will be exactly and only what we make it.

LTC KENNETH H. ROSE is deputy commander, Belvoir Research, Development and Engineering Center. He is a single-track R&D officer and a member of the Army Acquisition Corps.

THE ACQUISITION CHALLENGE

By LTG Billy M. Thomas

Introduction

As we look to the future after our magnificent victory in Desert Storm, we find that the Army has yet another challenge to face. This challenge is to achieve a smaller, technologically superior Army that retains all the capabilities we saw demonstrated in the gulf. This is a challenge the Army has responded to with intense effort. Countless hours of planning have gone into shaping the force in order to ensure that the Army of the future will have the wherewithal to fight and win when required.

At the same time as the total Army force structure is being "right sized" to deal with future threats, the industrial base of America will be shrinking. As less money becomes available for future procurements many contractors will face the question of whether or not they can stay in the defense business. Reduced funding also means we must get more value for our procurement dollars. We must maximize the effect of every dollar if we are to provide our Army with the wherewithal to fight and win. This, in a nut shell, is the Acquisition Challenge: WE MUST CONTINUE TO EQUIP A TECHNOLOGICALLY SUPERIOR ARMY WITH REDUCED FUNDING WHILE ENSURING THAT THE SMALLER RESULTANT INDUSTRIAL BASE IS COMPOSED OF THE RIGHT KINDS OF COMPANIES TO MEET THE NATION'S REQUIREMENTS IN FUTURE CONFLICTS. This challenge is just as important as the challenge to right size our force structure because, at stake, is the quality of the equipment our soldiers will have in the future and the ability to sustain them in peace and war.

The Acquisition Challenge must be addressed in several ways. We must commit to the quest for quality in all our procedures and products in both government and industry. It is only through achieving quality that we can eliminate the rework and scrap that sap our precious resources.

We must manage the downsizing of the industrial base and synchronize its capabilities with those of our arsenals and depots so that they all function at peak efficiency in the areas in which they are most competent and efficient.

We must become more efficient in all the steps that lead to the fielding of equipment to include research and development, test and evaluation, and our acquisition procedures. We must try to lower the cost of doing business for equipment already in the field so we can generate savings that can be applied to future programs.

We must ensure that our international programs and systems such as CALS (Computer-Aided Acquisition and Logistic Support) compliment the initiatives we take in these other areas. Finally, we must improve our education plans for our acquisition community to ensure unity of effort across all functional disciplines and a systematic way to train people to grow into more senior levels of responsibility.

We must have coordinated strategies in each of these areas if we are to meet the challenge.

The Quality Strategy

The quality strategy must start with the government side of the acquisition community. We are the people who write the requests for proposal (RFP). In doing so, we set the standard for everything we buy. It is not like walking into a fast food restaurant and ordering from the menu. When you do that you get a pre-designed product. We, on the other hand, set the parameters within which industry is going to work. We tell them exactly what the product is going to be and, frequently, how to make it. Therefore, it is government that decides virtually all the characteristics of the program and resultant equipment.

We design in the RFP what will be designed by the contractor. We must ensure that quality is built in up front in our writing of the RFP. We must use the principles of concurrent engineering and talk to industry through Advanced Planning Briefings to Industry (APBI) in order to ensure that the RFP is a quality product, written with the whole life cycle of the system considered.

We must foster quality programs such as the Malcolm Baldrige Award and the DOD Exemplary Facilities program. Participation in both are excellent vehicles to improve quality for industry. The Baldrige Award application is in fact an excellent diagnostic for government agencies. Everyone is better for their participation in these programs.

Both government and industry must make Total Quality Management (TQM) and concurrent engineering a way of life.

Industrial Base Strategy

The industrial base strategy must characterize the future, smaller industrial base by defining what work will be done in the government arsenals and

depots versus what will be done in the private sector. We must eliminate any overlaps and gaps so that each is doing only those things that are most cost effective given their core competencies.

In addition to sorting out who does what work, we must define what qualities we are looking for in the future industrial base. We want to maintain a sufficient balance of full spectrum capability companies that offer full engineering capability, production capability and service after sale. We want an environmentally safe industrial base that can produce defense and commercial products on the same lines. In that way the cost of the production line does not have to be paid by defense dollars alone.

We want to maintain a sufficient balance of full spectrum capability companies that offer full engineering capability, production capability and service after sale.

How do we shape this industrial base? The truth is we have always shaped the industrial base. Every contract award gives a breath of life to some contractor and tells a lot of others that they may have a problem. A contractor who never gets selected goes out of the base, either by choice or necessity. The cumulative effect of our source selections over time is an industrial base end state. We must manage our acquisition policies to seek out quality products from the best suppliers who provide full engineering support. In doing so, we will structure an efficient industrial base that will meet our needs.

Acquisition Improvement Strategy

The goal is to create quality solicitations that will be used to select "best value" from quality contractors. "Best value" means we put emphasis on what is really important while eliminating anything that does not add value. One characteristic of a "best value" solicitation is elimination of unnecessary military specifications and standards. In many areas today, commercial and international specifications and standards are equal or superior to military specifications and standards. We should not force, and ultimately pay for, retooling of companies to meet unnecessary specifications of our own design. We must ensure that every data deliverable does in fact add value and not just drive up the cost.

We must give up the notion that we know all there is to know about producing equipment. We must define what we want to put into soldier's hands and communicate that clearly to industry. We do not necessarily have to tell them HOW to do it in each case.

We must take advantage of innovative ideas. For example, flexible manufacturing (the ability to run multiple products on the same production line) coupled with "basketing" (procurement of like items bundled into a single multi-year contract) will give some security and flexibility to industry while giving flexibility and lower costs to the Army.

We must make past performance a critical factor in source selection. Companies that routinely run over on cost and schedule must be recognized as such. It is worthwhile to pay a little more and know that we will get a quality product on time for the agreed upon price.

R&D Strategy

We must reduce the cycle time from the laboratory to the production line. In order to do that, we need to use concurrent engineering principles early in R&D, as early as in the tech base. At the same time that we create something new in the lab we must be developing the processes to make it economically producible. We must clearly understand what areas of research we have the lead in and leverage international, commercial and academic sources for the rest.

R&D must not only focus on the future, but also on what can be done to enhance what we already have in the inventory. Technology insertion into existing systems can reap real savings.

Test and Evaluation Strategy

We must realize that you can not test quality into a product. Therefore, we must get our T&E community involved early in the design of solicitations. We should provide early, continuous, comprehensive evaluations to the materiel management team with recommended solutions. We should help industry to develop adequate process controls that will ensure product quality, thereby reducing the number of product tests required. This in turn reduces the cost of the project and improves the contractor's yields. Everyone benefits from

In the international strategy we must look for opportunities for cooperative development, cooperative production and foreign military and direct sales.

early involvement of the T&E community.

Operations and Sustainment Cost Reduction Strategy (OSCR)

Our O&S costs are the single largest element of the budget. About half of the Army's money each year goes into Operations and Sustainment Costs. In the OSCR, we direct our technology efforts at improving things already in the inventory to reduce those costs. When possible, we should redesign spare parts through technology insertion to reduce the unit cost and/or increase their reliability. We must look at the inventory of equipment and identify the cost drivers and apply the technology to make major or minor modifications if they will yield a significant cost savings. Industry can also share in this effort, and the profits/savings, through the value engineering change proposal system.

We must ensure through our concurrent engineering efforts that we build affordable O&S costs into future systems in the design phase.

International Strategy

In the international strategy we must look for opportunities for cooperative development, cooperative production and foreign military and direct sales. We must do a global search for the technological "golden nuggets" so that we can put them together with our "pot of gold." Where our needs and another country's capability match up is where we want to pursue international cooperative endeavors.

We must look at foreign military sales and direct sales a little differently than we have in the past. We should look at our production base and find the items for which we want to keep the production base warm. Then we have to look at the global markets and identify to whom the U.S. would be willing to sell these items and let that be known.

The bottom line is that we should facilitate international cooperation not only for the obvious international aspects but also for our industrial base.

Computer-Aided Acquisition and Logistics Support

CALS will provide an information exchange capability that will be important to our success. The automated interchange of information will allow for generation, management and distribution of technical data such as engineering drawings and logistical support analysis. CALS is one of the tools that will allow concurrent engineering to take place in our weapon systems design and development. Timely distribution of information is critical to be able to muster all the brain power to focus on a program.

Education

A civilian working in any part of our acquisition system can spend their entire career in one functional area and never be trained in any other. Although there are a few education opportunities that allow for a broader view, these are available to only a small percent of the population. The problem is that in order to achieve our quality strategy or any of the above mentioned strategies we must have a work force that can see the "big picture." Every supervisor must see not just their function but see it in the context of getting equipment into the hands of soldiers.

When we look at the military side of the house we see that at eight to 10 years of service we send EVERY officer to the Combined Arms Staff Service School (CAS3) and at 10 to 12 years we send officers to the Command and General Staff College (CGSC). CGSC then becomes a criteria for promotion to lieutenant colonel. As a result of these actions, the Army has assured itself of an officer corps that has a cross functional perspective. We need something similar for civilian employees if we are going to get all the functional areas working in the same direction. We must invest in the education of our people.

Summary

There is much to be done to answer the challenge of equipping a technically superior Army in an era of reduced resources. There is no doubt that the challenge is real and vital. American lives in some future conflict will depend on how we meet this challenge. There is no doubt that the industrial base will get smaller. It will get smaller with or without any action on our part. However, without a plan what will be left and will it be adequate for our needs?

Only by pursuing initiatives to infuse quality and concurrent engineering into all our products and demanding the same from our contractors can we meet this challenge. We must get the synergistic effect of these coordinated strategies if we are going to continue to meet the needs of our nation, our Army and our soldiers.

LTG BILLY M. THOMAS is the deputy commanding general for research, development and acquisition for the U.S. Army Materiel Command. In this capacity, he is also the deputy commander for international cooperative efforts. He was commissioned from ROTC at Texas Christian University and has a master's degree in telecommunications from George Washington University. He has commanded soldiers at all levels from platoon to brigade. Prior to his current assignment he commanded the Communications and Electronics Command at Fort Monmouth, NJ.

ARMY NAMES R&D ACHIEVEMENT AWARD WINNERS

Forty-six Army scientists and engineers have been selected to receive Department of the Army Research and Development Achievement Awards in recognition of outstanding accomplishments during 1990 that will improve capabilities of the U.S. Army and will contribute to the national welfare.

The achievement awards, which will be presented in the form of plaques, honor personnel employed at activities of the U.S. Army Materiel Command, the U.S. Army Corps of Engineers, and the U.S. Army Medical Research and Development Command.

U.S. Army Materiel Command

• U.S. Army Armament, Munitions and Chemical Command

Dr. Pai-Lien Lu was recognized for his work in developing an effective nondestructive inspection testing technology for evaluating adhesive bonding conditions in shaped charge warheads. This new technology provides means for improving shaped charge warhead performance. Lu is an employee of the U.S. Army Armament Research, Development and Engineering Center.

Miles C. Miller, employed at the Chemical Research, Development and Engineering Center (CRDEC), was commended for establishing a means of eliminating viscous liquid-filled projectile flight instabilities by use of an immiscible, low viscosity liquid additive. This accomplishment represents a significant achievement in solving a serious flight dynamics problem and providing a means for designing improved projectile configurations for future chemical and conventional munitions.

CPT (1LT when nominated for this award) Christopher J. Cramer, also assigned to CRDEC, was commended for the development of a model for the electronic and nuclear structures of potentially toxic phosphoranal radicals, thus obviating the need for their synthesis. His expertise has also provided detailed spectral predictions for use by researchers. By using cost-saving computational methods he has clarified likely pathways for the biodegradation of organophosphorous compounds in a fraction of the time normally required by standard biochemical procedures.

• U.S. Army Aviation Systems Command

Dr. Lawrence W. Carr was cited for his collaborative efforts with NASA, the U.S. Navy, and with civilian scientists in developing and demonstrating a real-time interferometric analysis system. This system, for the first time, permits accurate experimental study of the complex compressible flow that appears around helicopter airfoils during the "dynamic stall" condition that presently limits high speed and high maneuver flight of helicopters. His efforts greatly enhance the potential for dramatic improvement in helicopter performance. Carr is employed in the Aeroflightdynamics Directorate.

• U.S. Army Communications-Electronics Command

John B. Mitchell, Signals Warfare Directorate, was commended for his design, development and validation of complex signals analysis algorithms. The result is a rapid reprogrammable signals analysis/signals processing capability that provides the U.S. soldier with a low cost, highly effective, transportable, signal identification capability for tactical IEW units. His accomplishments allow upgrades to signal processing capabilities without requiring the procurement of new hardware or massive software changes.

Gregory R. Lorenzo (formerly an Army captain) and Kenneth J. Loffer received the award for their contributions to the improvement of the Army's Single Channel Ground and Airborne Radio System. Their design efforts led to improvements which allow frequency-hopping net communications for extended periods of time without the operational requirement for transmissions from an FH/M radio and without the accumulation of time regression. Their contributions will ease the procedural burden on the soldier in the field. Lorenzo and Loffer are employees of the Command, Control and Communications Directorate.

• U.S. Army Laboratory Command

A team comprised of Thomas A. Havel, Michael J. Zoltoski, John W. Runyeon and David C. Hackbarth of the Ballistic Research Laboratory was cited for their significant contribution to the research, development and demonstration of a new type of advanced reactive armor which is effective in stopping direct fire from unitary and tandem warheads, as well as small top attack munitions. Two versions of the technology have been developed, one suitable for protecting the front of a vehicle against direct fire munitions and the other suitable for protecting the roof of a vehicle against a bomblet threat. This new type of reactive armor is relatively insensitive to attack direction, correcting a deficiency existing

with the type of reactive armor fielded to date by the U.S. and other countries.

A team comprised of John G. Gualtieri, Donald W. Eckart, John A. Kosinski and Dr. Richard T. Lareau of the Electronics Technology and Devices Laboratory (ETDL) was recognized for its contribution to advancing the state-of-the-art in post-growth processing of quartz material. The team's development involves a new understanding of the role of the electrode in electrodiffusion processing of quartz material. The contribution will provide the Army and other DOD agencies with the quartz processing technology essential to impact a wide variety of weapons and satellite systems.

Another ETDL team comprised of Dr. Robert J. Zeto, Dr. David C. Morton, John C. Conrad, Richard C. Piekarz and Eugene Hryckowian received the award for a major contribution to advancing the state-of- the-art for the fabrication of thin film electroluminescent display panel devices. This process offers technology to achieve larger area, multicolor and high definition display panel devices that are beyond today's state-of-the-art. The contribution will provide the Army with display panel devices to meet present and future battlefield requirements.

• *U.S. Army Missile Command*

A team made up of Dr. Don A. Gregory, William M. Crowe, James C. Kirsch, Tracy D. Hudson, William R. Phillips and Ann H. Kissell was commended for successfully transitioning its basic research program in optical target recognition and tracking to a field demonstration. The demonstration concluded with a missile launch, autonomous guidance, and target impact on a test range at the MICOM Research, Development and Engineering Center (See Figure 1). This is the first time this technology has been tested outside stringent laboratory controls and is an important step in automatic target recognition research. The team members work at the U.S. Army Missile Command Research, Development and Engineering Center.

• *U.S. Army Troop Support Command*

Dr. Hie-Joon Kim, U.S. Army Natick RD&E Center, was recognized for the development of a method for measuring, by simple and precise means, the concentration of intrinsic chemical markers that are formed in the thermoprocessing of packaged foods and that can serve to validate the thermosterilization. His achievement will significantly improve the quality and nutrition of consumer foods and military rations.

Dr. Lynne Samuelson and Dr. Joseph A. Akkara, also with the Natick RD&E Center, were selected for the award for demonstrating new uses of monolayer technology to fabricate new polymers and material systems.

Samuelson demonstrated the controlled immobilization and orientation of protein-pigment complexes in monolayer systems derived from modified fatty acids. Such a system should lead to a new generation of camouflage coatings and materials that will change color with changes in environmental inputs. These systems could also lead to the development of electro-optical devices capable of detecting biological agents and hazardous chemicals. Akkara was commended for his achievement in developing a new enzyme catalyzed polymerization process for the synthesis of ordered and oriented polymers. His achievement has far-reaching significance for the military and the nation as a whole relative to the synthesis of new materials with improved functions and enhanced operational capabilities.

• *U.S. Army Tank-Automotive Command*

Dr. Steven M. Shepard, an employee of the Tank-Automotive Command's RD&E Center was cited for developing a system for the Army which extends the capability of existing infrared imagers by allowing them to image high speed events. An Army in-house imaging capability, essential for the investigation of entirely new thermal phenomena, resulted from his work.

U.S. Army Corps of Engineers

• *U.S. Army Cold Regions Research and Engineering Laboratory*

Dr. Edgar L. Andreas was recognized for his research in understanding the effects of air turbulence on optical transmission. His method of relating the optical transmission to commonly measured meteorological data has

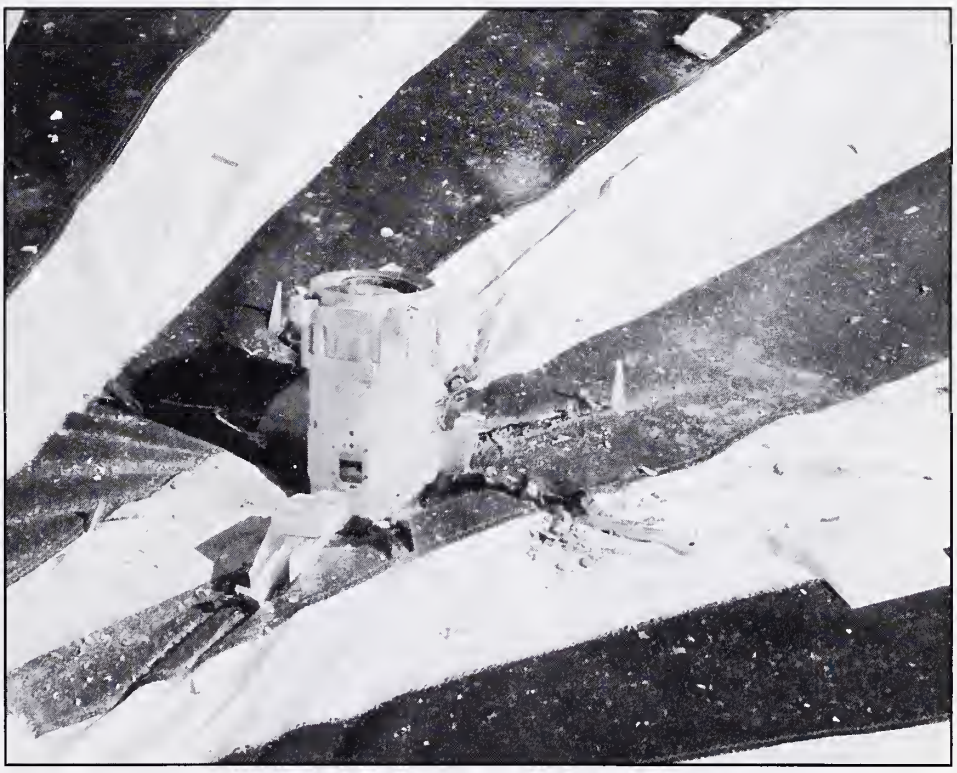


Figure 1.
Autonomous control via optical correlator leads missile to impact less than four feet from the center of a 35-foot target.

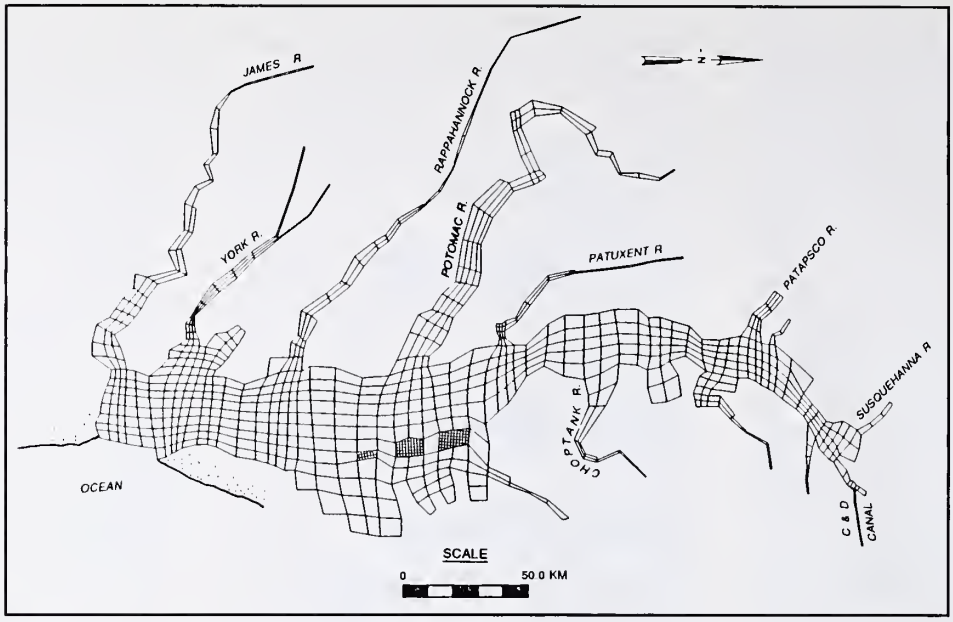


Figure 2.
Chesapeake Bay Model Computational Grid

applications in military programs for target detection systems.

• U.S. Army Engineer Topographic Laboratories

Dr. Jack N. Rinker was commended for outstanding achievements in pioneering and using hyperspectral imagery. Also, his knowledge of image analysis, spectral imagery and geology has resulted in providing detailed terrain information to ground forces in Operations Desert Shield and Desert Storm. Through these efforts, he materially assisted the mobility and survivability of the ground forces.

Daniel L. Edwards and Maurits Roos received the award for their primary role in developing a Terrain Information Extraction System, a pioneering, low-cost digital mapping system. Closer cooperation and technology transfer with the Defense Mapping Agency, the Defense Intelligence Agency, the Central Intelligence Agency, the U.S. Geological Survey and the National Ocean Survey have resulted.

• U.S. Army Waterways Experiment Station

A team consisting of Dr. Carl F. Cerco, Thomas M. Cole, Dr. Mark S. Dortch, Dr. Billy H. Johnson and Dr. Keu W. Kim were selected for their development and application of a three-dimensional, numerical hydrodynamic and water quality model of the Chesapeake Bay (See Figure 2). The model advances the state-of-the-art for using computer simulation for environmental assessment. It is being used to evaluate the effectiveness of nutrient control strategies for improving the water quality and living resource habitat of the Bay.

U.S. Army Medical R&D Command

•U.S. Army Medical Research Institute of Infectious Diseases

Dr. Timothy A. Hoover and Dale W. Seburn were commended for their development of procedures to rapidly detect and classify strains of *Coxiella burnetii*. Their development contributes to the diagnosis of infectious diseases.

• Letterman Army Institute of Research

SFC Keith W. Chapman received the award for directing the design, procurement, construction and operation of the Army sterile hemoglobin production facility. This accomplishment assures supplies of candidate blood substitutes for research in combat casualty care and saves the Army at least $500,000 per year.

Dr. John Patrick Hannon was recognized for developing a laboratory model of the pig to study the effects of severe bleeding. This model provided the supporting evidence in the development of an innovative new resuscitation fluid that promises to save the lives of many hemorrhage and shock victims both on and off the battlefield.

• Walter Reed Army Institute of Research

Mary K. Gentry was recognized for her creativity in generating monoclonal antibodies against infectious disease agents and also against macromolecules involved in nerve agent poisoning. Her research in these endeavors has resulted in the development of rapid, accurate and reliable diagnostic test systems as well as a novel method for generating antibodies, the extension of which will result in facilitating the use of synthetic peptides as vaccines.

Dr. Joan E. Jackson and John D. Tally were recognized for research leading to the development of a serum-free, chemically defined culture medium and in vitro radiorespirometric microprocedure (RAM) for parasite drug susceptibility testing. The RAM has been applied to epidemiologic surveillance for emerging parasite drug resistance and drug lot potency evaluation.

INTERVIEW WITH DR. ROBERT B. OSWALD

Director of Research and Development U.S. Army Corps of Engineers

Q. What is the primary mission of the Corps of Engineers and what types of research does it conduct?

A. That's an excellent question because many people, even in the Army, are not familiar with the dual role that the Corps of Engineers plays. The Corps has both civil and military missions. In addition to the military construction and related engineering mission for the Army, the Corps has given the Army a unique engineering expertise that, over the years, has led to missions in the civil works arena for the nation.

In the civil works area, we provide the nation with projects for flood control, navigation, hydro-electric power, water supply, recreation and wetlands management, and environmental enhancement. To give you an idea of the magnitude of this mission area, the Corps has constructed some 400 flood control dams and thousands of miles of levees, floodwalls, floodways and channels costing $23 billion—estimated to have saved $150 billion in damages. The Corps' 234-mile Tennessee-Tombigbee waterway project was larger than the Panama Canal.

In the area of military construction, the Corps of Engineers is the constructor for all Army and Air Force projects. This applies to all areas of the world except for the United Kingdom.

We also have an engineering program called Work for Others where the Corps of Engineers does work for other government agencies, such as the Environmental Protection Agency (EPA), and National Aeronautics and Space Administration (NASA). For example, the Corps constructed some major NASA launch sites.

In our military and civil missions the Corps also plays a key role in addressing major domestic emergency situations impacting on national security. The Corps provides support to others dealing with civil disturbances; natural disasters, such as earthquakes, floods and drought; and control of certain hazardous materials. In both missions the Corps plays a leading role in the environmental arena, drawing from each to insure the best and safest use of our resources.

In the future, I believe the Army's peacetime missions will expand the Corps' role in international assistance. The Corps has supported U.S. foreign policy by providing construction support to other nations. The work for others program I mentioned earlier also includes the reconstruction work in Kuwait, and potentially the proposed "Peace Pipeline," from Turkey to Saudi Arabia.

The R&D that the Corps executes is basically in support of our forces and nation in these areas, in addition to our support to AMC in the environmental areas.

Q. Civil works projects consume a large portion of the Corps of Engineers' program. What are some of the key spin-offs that have benefited the civilian community?

A. First of all, I think spin-off is the wrong word. The Corps of Engineers' civil works programs are aimed at supporting the civilian infrastructure. For example, the Corps is responsible for developing and operating navigation and flood controls. If you look at what the Corps of Engineers has done over the past 100 years in flood control or navigation of our rivers and intercoastal highways, you'll find that they have a current value of about $90 billion in terms of port projects, locks and dams, and navigation projects. The Corps built, operates and maintains a 12,000-mile system of coastal and inland waterways, including over 200 locks within those waterways. These locks, which represent an investment of about $60 billion, handle more than 600 million tons of cargo annually. The Corps provides all of the dredging and maintenance for our major coastal harbors, such as Los Angeles and Galveston, plus an additional 400 smaller ports around the nation and the Great Lakes.

Speaking of value to the nation, in the area of flood control, we have invested about $20 billion. In addition to the Mississippi, Missouri, and Ohio river system, we have about $20 billion in capital investment throughout the nation. This investment has provided savings to the nation of over $150 billion—about a seven to one return on investment.

All of our projects are not simply for water transportation or flood control. They are built so that you get a secondary product from it. The spin-off would be the recreational sites that are included. The Corps of Engineers is the second largest federal organization, second only to the U.S. Park Service, in terms of

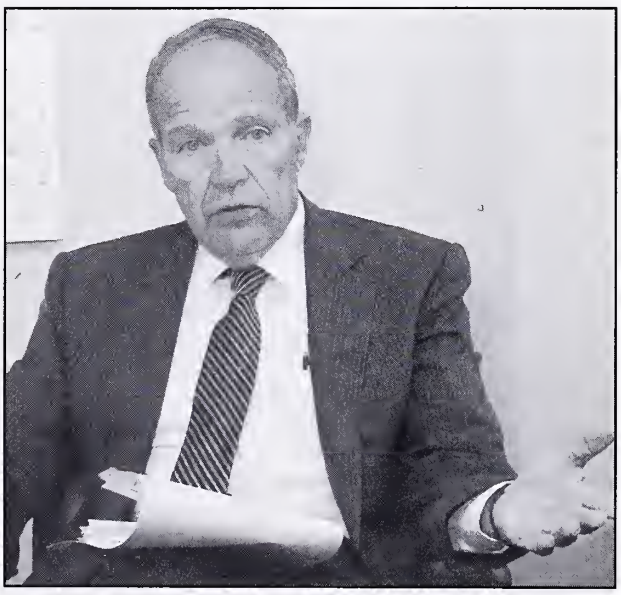


Photo by SGT Debra E. Troell

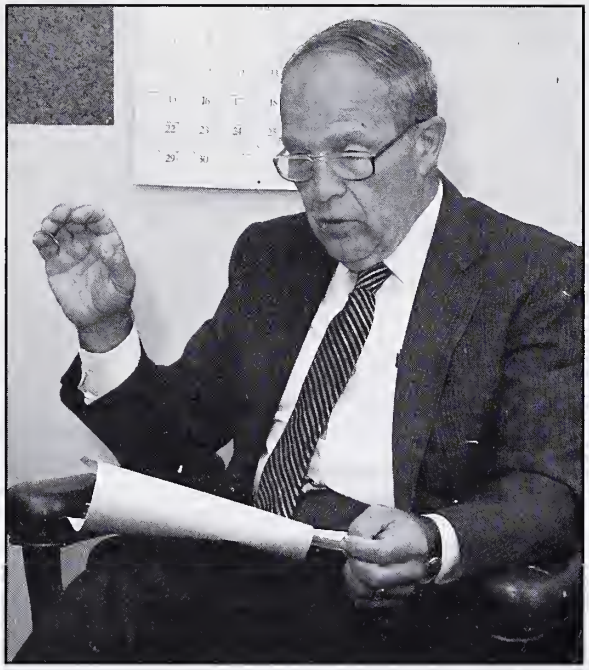


Photo by SGT Debra E. Troell

providing outdoor recreation. The Corps has about 4,400 recreation sites with approximately 188 million visitor-days each year. These are places where we've built a dam to create a water reservoir, which becomes a lake used by the public. Actually, about half of our civil works budget goes to the operation of the locks, the dams, and the recreational facilities.

Q. Do you believe the Army's laboratory restructuring effort will have a major impact on the Corps' R&D program?

A. No. I don't see that the Army restructuring will have as major an impact on the Corps' labs, as it's having on the AMC laboratories. First, the Corps is not restructuring into a single laboratory as the AMC labs are. We will have about a 72-position loss out of about 2,500 spaces. Those will take place mainly in areas where we had overlap and through efficiency efforts which will be made in lab management. In addition to that, Project Reliance, a tri-service, Air Force/Navy/Army, effort, will eliminate duplication and overlap and establish topical lead responsibilities within the three services. In the infrastructure and environmental sciences area, the Corps' laboratories have the largest capability. Consequently, we will see some restructuring. For example, the Air force will be solely dependent on the Army for survivable protective structures R&D. The Air Force topographic R&D work will be transferred to the Topographic Engineering Center (TEC) (formerly ETL) because TEC is the major topographic laboratory of the three services and the Cold Regions Lab will become the DOD center. Because the Corps' labs have the major capability in construction engineering and environmental sciences of the three services, this tri-service realignment may lend to a strengthened R&D effort.

Q. What role did the Corps of Engineers play in the recent Gulf conflict?

A. The Corps of Engineers played a major role from pre-Desert Shield through Desert Storm to the reconstruction of Kuwait. The bases that the U.S. and our allied forces moved into were largely put there by the Saudi government with the Corps of Engineers doing the construction. The Corps of Engineers put major naval and air installations into Saudi Arabia in the 70s and 80s. Those major modern bases were the ones our forces moved into and operated out of. The air base at Dhahran, for example, was a Corps-constructed facility. During Desert Shield and Desert Storm, the Corps built temporary barracks, roads, and provided the engineering troop support for the deployment and operations. Combat engineers, who mostly came out of the Reserve components, were some of the primary units providing mine breeching and emergency assistance after the war, such as handling refugees and establishing prisoner of war facilities. Since the liberation of Kuwait, the Corps has been operating at the request of the government of Kuwait to do basic damage assessment and reestablish basic power, water and sewage capabilities in Kuwait city. Currently, the Corps has a $450 million operating contract with Kuwait, with a follow-on effort expected to total an additional $200-300 million.

What might be of more interest to the readers of the Army RD&A Bulletin is that all four of the Corps' laboratories contributed to the support of U.S. forces in Southwest Asia. These contributions were covered in the May-June 1991 issue of Army RD&A Bulletin.

Q. Could you briefly describe some of the work currently performed by the Corps' Waterways Experiment Station?

A. The Waterways Experiment Station (WES) is our largest laboratory with about 1,500 people. They execute 85 percent of our civil works R&D and their programs range from military applications to civil works. So, let me just give you an idea about four of these programs.

On the military side, WES has been working with the Belvoir RDE Center in the development of stand-off mine detection systems. One such system just went through an advanced technology demonstration at Fort Hunter Liggett and at Fort Drum last year. The Remote Mine Detection System (REMIDS) uses an active laser and passive infrared detection systems to detect mines, whether on the surface or buried. Of the three systems tested in this advanced technology demonstration, it had the highest performance capability. The system consists of an optical scanner, real-time digital electronic sensing and parallel image processing computer, and a Global Positioning System receiver, operator display, and a telemetry system to relay the data to the ground. For the demonstration, this equipment was mounted on a Black Hawk helicopter and flown at about 60 meters off the ground at a flight velocity of about 60 mph. It detects mines through parallel processing of three different types of information. It collects three channels of what we call co-registered imagery, meaning the imagery is looking at the same spot on the ground at the same time. Of those three channels, two are active laser channels. Using a neodymium YAG laser to reflect energy off the ground, the system is polarized to look at the parallel and cross-polarization changes. The third channel collects far infrared emission data in the eight to 14 micron range and processes that data using a set of algorithms to detect mines versus the background imagery.

Moving to the military environmental quality side, one of the key things that the WES came up with last year is what we refer to as a cone penetrometer. This is a sensor for use at hazardous and toxic waste sites. Normally, at a hazardous and toxic waste site, you must sink a well which costs about $70,000. At periodic depths, you remove samples which are sent to a laboratory for wet chemistry analysis. That consumes another two months to determine the concentration of contaminants. The cone pen-

etrometer is a sensor on the end of a rod which is about 1-1/2 inches in diameter. The rod is pushed into the ground under several tons of pressure. The sensor, which is embedded in that cone, uses fiber optics and fluorescence spectroscopy to actively measure the contaminant that is present, providing a continuous read-out. This operation costs about $1,000 and provides near real-time read-out of the contaminants.

Now, I'd like to discuss our civil works wetlands research program. The Corps of Engineers is actually responsible for providing federal regulation of the wetlands. Any modifications, construction, or fill of any wetlands are regulated by the Corps of Engineers, as well as EPA. At the request of Congress, we have initiated a three-year, $22 million wetlands research program. As you can imagine, there are many types of wetlands in a nation as big as ours. Moving from east to west, coasts to lakes, coasts to rivers, or north to south, there is a tremendous variation in wetlands and their role in supporting fish and fowl ecosystems. This is a cooperative program involving the Corps of Engineers, the EPA, the U.S. Park Service, the Fish and Wildlife Service, as well as a number of conservation groups, such as the Ducks and the Sierra Club.

The latest program the Corps has started is the one on Zebra mussels. Zebra mussels are a bivalve that came into the country from the Baltics by mistake in the late 80's. Introduced to the Great Lakes, they're spreading all over through rivers like the Hudson. There is no natural predator for them on this continent. These mussels just adhere to any smooth surface, such as locks, the inlet to boat engines, or the inlet to turbines, where they multiply and grow quickly and cause blockages. It's just a terrible blight that we've got to learn to control. I don't know if we can do much more than control it. I don't think we're going to defeat it. So, the Zebra mussels are becoming or will become a major problem for our inland waterway system, particularly from St. Lawrence down through the Great Lakes. The task of developing appropriate controls will be carried out by WES in cooperation with other state, national and international organizations.

Q. How extensive are Corps of Engineers' efforts relative to environmental research?

A. Of all the DOD agencies, the Corps of Engineers has the broadest environmental R&D effort. We have both a civil works and a military program. In terms of the direct-funded program, in FY 92, the military program is expected to be about $19 million. In addition, the civil works program, which is very synergistic to the military program, will be about $14 million. In FY 92, we're expecting an additional $20+ million for the Strategic Environmental R&D Program. As a result, the Army's environmental program is growing and it covers a very broad spectrum. The primary objective is to reduce the cost of cleaning-up our past sins, prevent future pollution, comply with current standards and develop the tools which will allow our commanders to be excellent stewards of our natural resources. For example, we're doing R&D on how to clean-up using bio-remediation techniques. Our research program goes from basic research on the process to its demonstration in the field. In terms of environmental restoration, we have a major program. That program involves military-unique compounds that are toxic or hazardous and begins with the development of a full understanding of how those compounds enter into the ecosystems of both man and animal, and predicting the levels of clean-up required to insure safety to these ecosystems. That portion of the program is actually carried out for the Corps of Engineers by the Biomedical R&D Lab, a surgeon general's lab at Fort Detrick, MD.

Another portion of our environmental quality program deals with pollution prevention. Environmental restoration deals primarily with cleaning up past sins. We cannot continue to always clean up at the end of the pipe. We've got to get ahead of the source and prevent the generation of that waste, or control it to minimize the amount of waste that we must dispose of. So, the Corps of Engineers and AMC have developed a joint pollution prevention program to address prevention in production and maintenance.

I think the Army is probably the DOD leader in terms of proactive stewardship. In the past, we have, like our ancestors, felt that we had sufficient land for unlimited and unrestricted use of this resource. This is just not true. Now, we train with more effective weapons with higher speed and greater range. This is more detrimental to the environment. As part of the military environmental programs, we're developing techniques so that the trainer can select and schedule areas for training which minimize the negative impacts. Once a certain region is stressed, training is moved to another part and re-vegetation is initiated in order to allow the first area to recover while another is used. So, essentially, the use of the land is managed to minimize the environmental impact. This is being done on a broad scale from managing tanks and troops to managing the training activities where noise levels are a concern. The Corps is installing noise detectors and developing a software system that, given certain flight patterns and weather conditions, predicts the noise level in the surrounding community. The trainer thus predicts what the level would be and tries to minimize any adverse impact in the surrounding civilian community, regardless of whether the source is artillery fire or aircraft. The Corps is developing and installing these tools, putting them in the hands of trainers so that the Army can become better neighbors and stewards of the nation's natural resources.

Q. Some people contend that the government is losing its battle in trying to clean up the environment. What is your response?

A. That may still be a perception among some. However, I feel the Army is making great strides in the environmental restoration program and has gained recognition of this from both environmental groups and regulators. This perception you referred

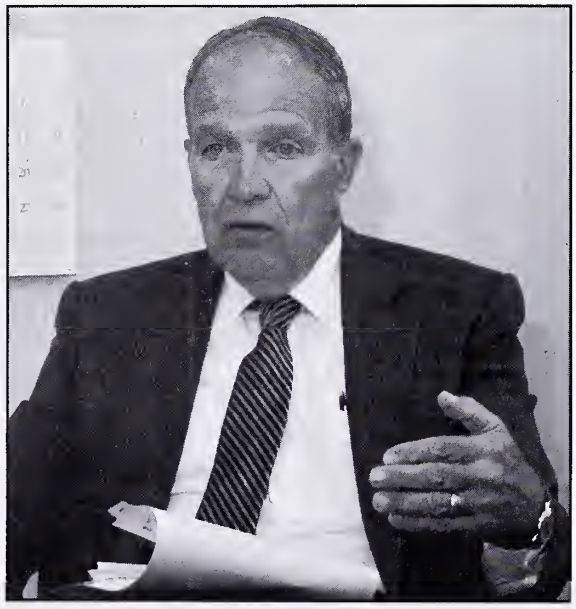


Photo by SGT Debra E. Troell

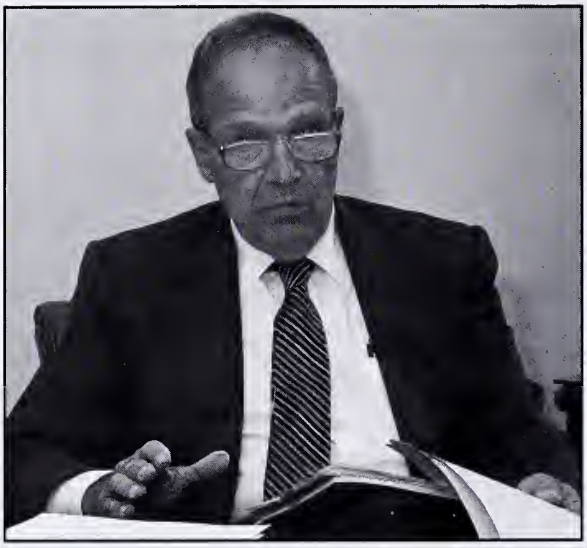


Photo by SGT Debra E. Troell

to may have been created when the Army conducted a site reassessment several years ago. This "relook" added additional sites that required assessment and some additional sites to be cleaned up. As an example, in 1989 we had 8,642 sites to be assessed and in 1990 this number was expanded to 10,459. Although several sites are being added to the list each year, our assessments are essentially complete. Of these 10,459 sites, we know that 5,036 are not presenting a hazard to human health and the environment. We currently have 2,000 sites that will require some level of remediation. Of these sites, we have 400 underway or completed. So, the Army is making very steady and measured progress on a large and complicated work area. We continue to show DOD leadership by dedicating the required personnel resources both within the Army's Toxic and Hazardous Materials Agency and the Corps district offices who work hand-in-hand to accomplish this very important and challenging job.

Q. How would you assess the quality of people now working in the Corps' R&D community?

A. I'd say they're excellent, just excellent. For a number of reasons...Probably, the first reason is that the Corps laboratories have what I'd call a national ranking. There's no industrial counterpart to our laboratories. As a result, we don't have to compete with industry to attract the experts and researchers that we have. A second advantage is that two of our labs are located basically on or adjacent to a major college campus. For example, the Cold Regions Research and Engineering Laboratory (CRREL) is in Hanover, NH, located right next to Dartmouth. It has some excellent exchange programs with Dartmouth College for graduate students in terms of research and training. In the United States, if you want to do cold research, the best place to go is CRREL.

It's a very similar situation with the Construction Engineering Research Laboratory. It sits on one of the top 10 engineering school campuses at Champaign-Urbana at the University of Illinois. The Corps is able to attract some of the key graduate students from the civil engineering department, and from many of the other departments there. We have a reciprocal exchange agreement where we do part of the research on campus and part in the lab. At the Waterways Experiment Station, if you want to do coastal engineering research, the Coastal Engineering Research Center is the place to go. When you look at civil engineering, there is no General Dynamics, Martin Marietta, or Ford doing research because the industry itself is so fractionated. There are probably about 200,000 construction companies in the United States. Because of their large numbers and cost competition in the bidding process, most of them do not have a major industrial research capability. So, the Corps of Engineers laboratories represent a national capability and as a result, our labs attract excellent people.

Q. What areas of research do you think will be most important during the next decade?

A. Generally, the only constant is change and whatever I say today will be wrong a year from now. But, as I direct a program for the immediate future, I'm putting emphasis on the environmental quality R&D area. That's an area which is a major concern for the nation and for which the R&D investment has a demonstrated payoff potential greater than 1,000 to one. So, it provides an opportunity for tremendous leverage of R&D funds.

Another area of emphasis is to gain a full understanding of the battlefield environment and its role in smart weapons performance and operation. In the past, the developers of our smart weapons put a tremendous amount of effort into detecting the target in what they call a clutter environment. Yet, of all the information the sensor must process, more than 99.99 percent is information generated by background environment—trees, bushes, dirt, water, snow, rain, grass. This "clutter" dominates the false alarm rate and we have not put an adequate effort into fully understanding the signatures that are generated by the natural background. The Corps of Engineers, being the environmentalist for the Army, has a responsibility to develop that understanding and work with our AMC counterparts in developing smart fire and forget weapons, and smart target acquisition systems. So, this is another area where I'm placing emphasis.

I also see the continuing need to develop technology to detect mines is still a major problem and we will continue to support AMC in that effort. We have a unique group in the Corps with a demonstrated capability and I think that they will be useful in continuing support to the Army in this role.

Another area I want to address is the aging infrastructure system, both the military and the civilian. In support of the Corps' civil works program, we have developed what I'd call a repair and maintenance program, which addresses the key problem of how to restore existing locks and dams to fully extend or double their lifetimes. As I indicated earlier, there are more than 200 locks which are approaching 50 years or better in age. I told you also, that I think we have about $60 billion invested in these locks. The nation cannot afford to replace these on a one-for-one basis. The problem is, how to restore them so that their functional life is extended at least another 50 years at a much lower cost than replacing them. The Corps has developed and demonstrated many new techniques under that program at a cost of about $35 million, and already we have a return on investment of about $150 million. I would like to think that given the opportunity, a very similar program could be developed for other elements of the nation's infrastructure, such as roads, bridges, water supply, power, and sewage. The Corps of Engineers will certainly continue to progress towards affordable technology to extend the life of the civil works infrastructure, as well as that of the Army's military bases.

Two and one-half-ton cargo version of the Family of Medium Tactical Vehicles.

TACOM AWARDS CONTRACT FOR NEW MEDIUM TRUCKS

By George Taylor

On Oct. 11, 1991, the U.S. Army Tank-Automotive Command (TACOM) awarded a $1.2 billion, five-year production contract to the Texas-based Stewart and Stevenson Services, Inc., to build a new family of 2-1/2 - and 5-ton tactical trucks for the Army.

Known as the Family of Medium Tactical Vehicles (FMTV), they are planned for introduction to troops in October 1993. They will replace the M44-series 2-1/2-ton trucks and the M39- and M809-series 5-ton trucks now used by the Army, Marine Corps and Air Force. Additionally, they will supplement the newer M939-series 5-ton trucks.

Stewart and Stevenson is heavily involved in manufacturing equipment for the U.S. Armed Forces in support of foreign militaries. Since World War II, the corporation has built generator sets and turbine engines, and has maintained a high standard of quality workmanship that exceeds government military specifications requirements.

The Stewart and Stevenson concept was one of three submitted earlier in response to a TACOM Request for Proposal. That proposal called for a Level III Nondevelopmental Item (NDI) Program that would provide a new generation of medium tactical vehicles that would use existing or modified commercial hardware and common components wherever possible, to minimize developmental costs and lead time.

Under terms of the contract, the company will build 11,000 trucks—approximately 60 percent of which will be 2-1/2 ton and 40 percent 5-ton versions—over the next five years.

The trucks will have full-time all-wheel drive and an improved suspension system offering better off-road mobility than the existing 2-1/2- and 5-ton vehicles. The 2-1/2-ton version will have a four- wheel design and the 5-ton truck will use six wheels.

The 2-1/2-ton version will come in only a van and a cargo-truck variant, but the 5-ton version will include two cargo models—one of which will have a material-handling crane—a dump truck, a wrecker and a tractor. The cargo bed will be available in standard (14-foot) and long steelbase (20-foot) versions. Several add-on kits will also be available that will make the vehicles suitable for special roles, such as deep-water fording and operation in Arctic regions.

A standard cargo model of the new 2-1/2-ton version and a standard 5-ton cargo and dump configuration will be air-droppable and deployable by a Low-Altitude Parachute Extraction System (LAPES). (In a LAPES deployment, a parachute pulls the pallet-mounted truck from the rear of a cargo plane flying about 20 feet above the ground.) They will also be transportable by helicopter.

According to CPT Stephen M. Corcoran, a spokesman for the TACOM-based Medium Tactical Vehicle Project Manager Office, several FMTV features will significantly improve vehi-

Five-ton tractor version of the Family of Medium Tactical Vehicles.

cle performance over the current trucks. He said these include a new axle design developed by Rockwell International, in which some of the drive-reduction gears—normally located in the differential housing at the center of the axle—are contained within each wheel hub. This change reduces the size of the differential housing, thereby making it possible to improve cross-country mobility by providing more vehicle ground clearance, increasing wheel travel and reducing the weight of the axle.

Another feature, Corcoran said, will be an extra-wide Michelin steel-belted radial-ply tire called the Supersingle, which will provide improved traction, longer tire life and eliminate the need for dual wheels. Moreover, a central tire inflation system manufactured by Eaton Corporation will allow the driver to change tire pressure from inside the cab. He explained that this will make it possible to maximize traction for operation on paved highways, sand, cross-country terrain, and when immobilized in mud or snow.

Corcoran said both trucks will be powered by a new, lightweight commercial six-cylinder turbocharged diesel engine developed by Caterpillar that weighs less than the old 2-1/2- and 5-ton truck engines, yet delivers more horsepower. The 5-ton trucks will use a 290-horsepower version of the engine, while a 225 horsepower version will drive the 2-1/2-ton vehicles. He said the transmission for both trucks will be a new Allison-built, electronically controlled, seven-speed automatic transmission that is lighter, smaller, easier to maintain and has fewer parts. It is designated as the "Allison World Transmission" for the commercial market.

Corcoran also talked about other improvements that will result in a dramatic reduction in FMTV life-cycle costs. He noted, for instance, that the trucks will use the same instrumentation and controls, as well as a common three-man cab and many of the same mechanical and electrical components. He said this commonality will save money by minimizing the number of unique spare parts that field units will be required to stock and simplify operation and maintenance training requirements. "This should make a big difference in our operating costs. Because with what we have out there now between the old 2-1/2-ton and the different 5-ton variants, there is no component commonality," said Corcoran.

Corcoran also noted that the vehicles will have built-in diagnostics that will make maintenance and repairs easier. "Even the transmission," he said, "has its own diagnostic computer that will tell the driver something is wrong by displaying a code. Then, when the driver takes the vehicle in for maintenance, that stored maintenance code will save the mechanic a lot of time by telling him what needs fixing."

Corocoran added that mechanics will be able to repair the new trucks easier and faster because, unlike the current 2-1/2-ton models, they will incorporate a cab-over-engine design in which the cab tilts forward to facilitate quick engine and transmission removal and installation.

According to COL Larry Day, project manager for the Medium Tactical Vehicles, current plans call for the Army to buy 102,000 2-1/2- and 5-ton trucks over the next 30 years. "The program over its life is estimated to be about a $20 billion acquisition. In operation and support costs alone, we will save $40 billion. So for every buck we invest, we will get two back in O&S cost savings. For the first time in 20-plus years, we will be able to say, This is not your father's 2-1/2 ton," Day said.

GEORGE TAYLOR is a technical writer-editor for the U.S. Army-Tank Automotive Command. He has a bachelor's degree in journalism and a master's degree in communications from Michigan State University.

DECLINING, DIVERSIFYING, AND DISAPPEARING

Radical budget reductions were the trigger—but only one of the causes—for an epic slide of the defense industrial base.

By John T. Correll
and Colleen A. Nash

Editors's Note: The following article, the first of two parts on the defense industrial base, was initially published in the October 1991 issue of Air Force Magazine. The second part will appear in the March-April issue of Army RD&A Bulletin. Both articles were adapted from an Air Force Association study titled "Lifeline Adrift: The Defense Industrial Base in the 1990s." For a complete copy of the study, send $5.00 to the Aerospace Education Foundation, 1501 Lee Highway, Arlington, VA 22209-1198.

In World War II, American industry mobilized to create the legendary "Arsenal of Democracy," turning its output from consumer goods to war materiel and achieving extraordinary rates of production. The great arsenal, however, lasted only as long as the war did, and we will not see its like again.

What the United States maintained through most of the postwar period was a defense industrial base (never the organized "military-industrial complex" of popular mythology) made up of prime contractors, suppliers, and subcontractors capable of meeting defense technology and production needs.

By the early 1980s, even this limited industrial base was deteriorating badly, especially at supplier and subcontractor levels. By 1982, Air Force Systems Command estimated that the supplier-subcontractor base had shrunk by more than forty percent over fifteen years.

Bad as it was, however, the decline in the 1980s pales by comparison with what is happening in the 1990s. For many reasons, conditions were ripe for a slide of epic proportions. One of those reasons—radical defense budget cuts—triggered the slide.

The heaviest losses are occurring today in the supplier and sub-contractor tiers. Now as then, some of the worst problems are at the component level. In the 1990s, however, concern has escalated to larger parts of the defense industrial base.

The Navy has only two sub-marine suppliers: Newport News Shipbuilding of Newport News, Va., and Electric Boat of Groton, Conn. With Navy shipbuilding on the wane, there is concern that only one submarine yard will survive.

The production base for main battle tanks may go cold as early as December 1992, after the end of the M1A2 Abrams run. First deliveries of a next-generation tank, the "Block III," are projected to 2003.

The U.S military buys helicopters from five U.S. firms—Bell Helicopter Textron, Boeing Helicopter, McDonnell Douglas Helicopter, United Technologies/Sikorsky Aircraft, and Kaman. Some analysts speculate that two, perhaps three, might fold.

Termination of the Peacekeeper missile creates an unplanned break between last deliveries (1994) and the production start for the Small ICBM, a weapon whose political survival is not assured.

The scope and magnitude of the decline are underscored by an increase in concern that the industry may not be able to meet the needs of the military in wartime, that it is now overly dependent on foreign sources, and that U.S. technological leadership is waning.

Vindicated but Gone

The Persian Gulf War was widely (and correctly) viewed as a vindication of the defense industry, but, in many ways, the war's successes reflected an industrial base that no longer exists. Even as the nation watched the war on television, the companies that produced the impressive weapons were releasing workers, closing plants, and seeking nondefense business.

The U.S. government is not completely convinced there is a defense industrial base problem. Even when it grants that one may exist, Washington frets about what steps to take, if any. The de facto strategy is to let the market fires burn themselves out, then see what can be made of whatever is left of the base.

Through the 1980s, there were repeated warnings that the defense industry could not expand its production to meet wartime demands in less than eighteen months and that it was not possible to increase the output of even the most important weapons and war materiel much faster than that.

The issue began to attract broader attention in 1987, when the Defense Science Board warned that the U.S. was losing its lead in the design and manufacture of electronic components and that the armed forces might soon be dependent on foreign suppliers for capabilities needed to maintain technological superiority.

Defense spending (adjusted for inflation) began to fall in 1986. Wholesale reductions, however, began with the November 1987 "budget summit," when the Reagan Administration made concessions to Congress and agreed to reduce the five-year defense plan further by more than ten percent. Since then, nearly all major defense programs have been touched by wave after wave of reductions. Dozens of programs were canceled outright and others were curtailed or "rescheduled" on short notice.

Surveying political changes in the

Soviet Union and the breakout of the Warsaw Pact, the Bush Administration and Congress reached a consensus in July 1990 that defense budgets and forces could probably be cut by another twenty-five percent over a five-year period.

By then the defense industry was already in flight. Major contractors had begun to cut their loses, diversify, and move to other markets. Defense stocks had lost forty percent of their market value over five years, and the price-to-earnings ratio had dropped to about half that of Standard & Poor's 400.

By the summer of 1990, the trend was so pronounced that the market was glutted with defense divisions for sale. Prices dropped so far that several companies decided to delay or forget about these divestitures.

The aerospace industry, a pillar of the defense industrial base, is doing well on the overall balance sheets, but that is attributable largely to the backlog of orders from the airlines, not to defense business. The relative profitability of the industry is often debated, but the quip, recounted by Kenneth Adelman and Norman Augustine, that "you can make a small fortune in the defense business—provided you start out with a large one" is uncomfortably close to fact for a number of firms.

A Shrinking Supplier Network

Numbers are not the whole story, but they are part of it. One widely accepted estimate holds that, between 1982 and 1987, the number of defense suppliers dropped from 138,000 to fewer than 40,000. Some (including 20,000 small firms) went out of business, but most simply moved to nondefense markets.

The Pentagon does not know how much further the shrinkage has gone, and neither does anyone else. During the preparation of the Air Force Association's report "Lifeline Adrift: The Defense Industrial Base in the 1990s," we heard varying estimates from informed sources on how deep the decline might go before leveling out. Speculation ranged from a low of fifteen percent to a high of fifty percent.

Small suppliers are disappearing and even the giants of the industry have been shaken severely. Of 244 firms responding to a 1990 survey conducted by the Defense Systems Management College, twenty-one percent said they were cutting back on or getting out of defense business.

Malcolm Currie, chairman and CEO of Hughes Aircraft, says that "if you think that much downsizing, mergers, and companies going out of the defense business [has] already occurred, you ain't seen nothing yet."

Ironically, this accelerated decline of the defense base happens at a time when DOD has adopted a new defense strategy, featuring smaller forces, reduced deployment overseas, and heavier dependence on "reconstitution of forces." In fact, the Joint Chiefs of Staff say that "reconstitution may well prove to be the linchpin of America's long-term security."

According to the new strategy, Washington must be prepared for a range of "plausible circumstances that might call for the application of U.S. power." The scenarios vary in scope, intensity, consequences, and probability of occurrence. Minor conflicts would be handled by a "base force," smaller than today's but superbly trained and equipped. Reconstitution is seen as required for the more extreme scenarios, such as reemergence of a global threat from the Soviet Union.

Adm. David E. Jeremiah, Vice Chairman of the Joint Chiefs of Staff, says that the reappearance of a major new Soviet threat would be preceded by a long mobilization and "therefore, we will have time to reconstitute the necessary forces—provided we still have the infrastructure on which to build them."

A Hole in the Strategy?

Several assumptions are implicit: The base force can deal with all except the most extreme contingencies. There will be ample warning to prepare for broader conflict. Given time, the armed forces and the supporting industries will be able to regroup and respond.

Under the new strategy, the Persian Gulf War would be rated as a "major regional contingency." When Saddam Hussein invaded Kuwait last year, the twenty-five percent drawdown of U.S. forces had not yet begun in earnest. Stock levels, built up in the 1980s, were high. U.S. forces went to war with modern high-technology equipment, acquired in more prosperous days.

Even so, U.S. forces and industry worked at a punishing pace to prepare for the fighting, which did not begin until nearly six months after the invasion. Despite the brevity of the war, the Pentagon had begun pulling its surge production options together before the conflict ended.

In a similar "major regional contingency" of the future, the base force would be smaller and perhaps less well provisioned. It may or may not have the advantages U.S. forces enjoyed in the Gulf War: an incompetent adversary, extraordinary international support, and more than five and a half months to get ready.

With smaller conventional forces, the Soviet Union might require considerable time to bulk up before it could once again present a global threat. Even after reductions and reforms, the Soviet armed forces could mount a challenge far exceeding anything seen in the Gulf War. U.S. European Command believes that the Soviets still will be able to move thirty divisions in thirty days along a main axis of attack west of the Urals.

Defense analyst Jacques S. Gansler points out that, in all of its wars, the U.S. has been able to mobilize forces much more rapidly than it could equip them. Not everyone is confident that enough of the base will survive for reconstitution and mobilization in a future emergency.

In this year's defense authorization bill, the House Armed Services Committee (HASC) expressed both general and specific concern about the industrial base. It noted, for example, that the U.S. shipyard industry lost a third of its capacity in the 1980s. With business from the Navy diminished, it will not be possible to sustain the shipbuilding base without major new commercial orders.

Under current Air Force plans, the last F-16 fighter will roll off the line in 1993. Until F-22 Advanced Tactical Fighter output begins in 1997, HASC observed, there will be no ongoing production of Air Force fighters. Contrary to the Pentagon's wishes, the House voted to extend F-16 production beyond 1993, a move not reciprocated in the Senate. The Air Force says that with tactical force structure decreasing from thirty-six wings to twenty-six, it has no need for new F-16s.

Further, the Committee said, "with the expected twenty-five percent reduction in the defense budget between now and 1995, the ability to mobilize will take on even greater importance."

Slow Revival

Even if the defense industrial base could be revived at a later date, it could not be done quickly. The Joint Chiefs of Staff estimate that, by 1997, it will take two to four years to restore production capability to the 1990 level, which was not that great a benchmark. The Joint Chiefs also note that only one or two suppliers, remain for some critical items, adding that "we do not have either the authority or the resources to ensure that even this level of infra-structure will remain in the future."

Examples abound of the fragility and vulnerability of the industrial base at the supplier-subcontractor level. In May 1987 an accident destroyed a plant that produced half of the nation's ammonium perchlorate, and it took a year and a half to get a new plant running. In November 1988, the Pentagon discovered that its only domestic source of aerospace-grade rayon was closing its doors, a belated discovery that sent the government scrambling to qualify another source.

What most distresses some analysts, however, is that major problems now are beginning to affect prime contractors.

One major case is the U.S. submarine-building industry. Tenneco's Newport News Shipbuilding and General Dynamic's Electric Boat Division are locked in a major struggle for survival that might leave the U.S. Navy with a single supplier of underwater warships.

The submarine business is concentrated in only a relative handful of major production programs. The SSN-688 Los Angeles—class, nuclear- powered attack submarine is still in production, as is the Navy's Ohio- class Trident boat, a strategic-missile-firing submarine. In addition, the Navy plans to buy nine SSN-21 Seawolf-class, nuclear-powered attack boats over the next six years.

The Navy has split the SSN-688 orders more or less evenly. However, Electric Boat took contracts for all of the Tridents and the first two Seawolfs. Newport News is in litigation with the Navy over the award and claims that, unless it gets some Seawolf work, it will have to close facilities.

The Navy argues that Newport News has a good backlog of orders for Los Angeles-class submarines, as well as orders for three Nimitz-class aircraft carriers.

Preserving the Tank Base

Tank production is another concern. In its 1991 budget, the Army proposed terminating tank production after the M1A1 and M1A2 runs on the grounds that it could not afford to spend money on tanks it does not need. General Dynamics, the sole U.S. builder of main battle tanks, has plants in Warren, Mich., and Lima, Ohio, but plans to close the Warren facility.

There is strong pressure from Congress to preserve the tank industrial base, with three possibilities seen for keeping the line open. One calls for upgrading the "vanilla" M1s, now roughly half the total Abrams fleet, to M1A1 standard. Option two calls for updating the M1A1 fleet to M1A2 configuration. Finally, the Army could upgrade the plain M1 to M1A2 configuration. The House Armed Services Committee prefers the third option and voted research and development money to pursue it.

Several M1A2 export deals are pending. If they pan out, the M1 line could stay open until 1995. There is strong competition, however, from several other nations, including Brazil, Britain, and Israel.

Experts predict that there will be considerable military helicopter business in the future. The question is whether there will be more than a handful of U.S. producers around at that time. Boeing and Sikorsky have been selected to build the Army's new RAH-66 Comanche (formerly Light Helicopter). What happens next depends on final decisions affecting the Longbow Apache, the V-22 Osprey, and foreign military sales. Without foreign sales, the helicopter base likely will face serious trouble.

In the area of ICBMs, industrial sources say it will be difficult to maintain suppliers and other critical assets during the upcoming break in strategic missile production, particularly in view of the Small ICBM's uncertain future.

According to an industry assessment, the end of the Peacekeeper program, if it holds, will mean the release or retirement of 8,000 scientists, engineers, and specialists. The lost knowledge and experience of this work force cannot be quickly recreated.

At present, there are two suppliers of fighter engines, Pratt & Whitney and General Electric. Concern has receded since the ATF engine contract went to P&W last spring. The Air Force says industrial base considerations played no part in the selection, but the choice of P&W—which needed the work—leaves the fighter engine production base in relatively good shape. GE will be sustained for some years by engine work on the Navy's F/A-18. It will also provide the engines for Japan's S-3 fighter (also known as FSX).

To the surprise of no one, Air Force Systems Command finds that its supplier-subcontractor base is soft and declining in numbers. An anomaly of the decline is that, in some instances, waiting times for components have actually decreased. The production lead time for landing gears, for example, dropped from twenty-seven months in 1983 to only twenty months in 1990. This appears to be temporary, an excess capacity in the supplier chain caused by the rapid drop in business. Analysts expect that, as vendors drop out, waiting times will increase once more.

The case could be made that shrinkage of the supplier-sub-contractor base is not all bad. Tough times will weed out the weak and the marginal players and thus provide a clearer field for the best and most dependable. Whatever the merits of such arguments, the U.S. seems destined to enter the future with a strategy that counts on the capability to reconstitute forces and a defense industrial base that is declining on all fronts.

No one expects the defense industrial base to disappear completely. After the decline has run its course, a substantial number of well-qualified suppliers will remain. Despite such problems as foreign dependence, limited competition, long waiting times for components, and occasional breaks in the supplier chain, the industrial base will probably be able to meet planned production requirements in peacetime.

There is less assurance that it will be able to respond adequately in wartime. If not, the U.S. will have deceived itself into accepting an industrial base that looks good until the shooting starts and then flunks the test that really matters.

The second part of this article, dealing with foreign dependence in the U.S. defense industrial base, will appear in the March-April issue of Army RD&A Bulletin.

JOHN T. CORRELL is editor-in-chief of Air Force Magazine.

COLLEEN A. NASH is associate editor of Air Force Magazine.

SOLVING THE HELICOPTER ROTOR BLADE EROSION PROBLEM

By Mike Hoffman
and Tim Rickmeyer

With the announcement of Operation Desert Shield, the U.S. Army Aviation Systems Command's (AVSCOM) Research, Development and Engineering Center immediately started compiling an action list of requirements to support the operation. Operating in a desert environment was not new since there were many lessons learned available from foreign customers, other special operations (Bright Star), and CONUS operations at such sites as Fort Bliss and the National Training Center. The main difference was that this would involve extended time with many operations from remote sites. Although there were many areas to be addressed, one permanent one was the need for helicopter rotor blade protection.

Specific operational experience in Saudi Arabia had already been obtained through a Foreign Military Sales (FMS) agreement with the Saudi Arabian Government. A derivative of the Black Hawk, called Desert Hawk, had already operated for several hundred hours—but primarily from a fixed base. In developing Desert Hawk, a tape protection system was devised for the leading edge of the blade along with a painted coating for the tip cap.

However, for Desert Shield, many models of helicopters had to be addressed and the lead time production for tape kits required alternative considerations. Army R&D efforts had addressed many materials in the past to provide for sound protection. A review of these was conducted to develop an overall program to meet the need.

Based on past experience, rotor blade erosion occurs at 10 to 15 times the normal wear rate. Similar wear rates were previously experienced by the U.S. Army during training and actual combat exercises. "Team Blade" was formed to address development, testing, procurement, and application requirements in a concurrent effort. The success of this team in anticipating the problem and getting rotor blade protection installed on the thousands of blades involved in Operations Desert Shield and Desert Storm is a tribute to the dedication of DOD civilian support for the soldier in the field.

If the erosion rates were left unchecked, normal supplies and maintenance combined with accelerated contractor output to produce and install projected replacement parts, would not have been capable of supporting short or long term rotary wing aircraft requirements in Saudi Arabia. However, Army R&D efforts, both before and during Operations Desert Shield and Storm provided an invaluable solution to the helicopter rotor blade erosion dilemma: rotor blade erosion protection kits.

Various U.S. Army research programs provided input to the current rotor blade erosion protection kits developed by AVSCOM's Directorate for Engineering. The common material among all these programs recommended for the prevention of adverse effects when flying in desert environments is polyurethane. Polyurethane has a long history of demonstrating excellent sand erosion resistance.

Either full or partial polyurethane erosion strips are standard material applications to the AH-1 K747 rotor blades, UH-1 composite main rotor blade, and OH-58D main rotor blade. Yet, a comparative weakness of polyurethane to rain erosion has resulted in metal being used toward the tip of these blades—the area most susceptible to erosion.

Some of the major efforts which contributed to development of the current erosion protection kits included studies on corona (halo) effect on CH-47 rotor blades (see Figure 1), sand erosion effects on UH-60 rotor blade tip caps,

Figure 1.
Corona (halo) effect on CH-47 rotor blades.

and sand erosion protection for foreign military sales UH-60 Desert Hawk aircraft.

Results of the corona effect studies on CH-47 rotor blades, conducted at the U.S. Army Aviation Technical Test Center (ATTC), yielded the discovery of Task L-100 polyurethane coating in 1980. This coating prevents sparking and erosion of rotor blades, encountered when sand granules impact the titanium rotor blade leading edges.

Polyurethane materials such as Task L-100 are preferred since they are resilient against sand impingement and are excellent for adhesion to a variety of substrates.

Task L-100 coating is a vital part of the current blade erosion protection program. Polyurethane coating is now utilized to protect main and tail rotor tips on all U.S. Army helicopter models. If other portions of the latest blade erosion protection kits are not available, Task L-100 may be utilized to cover the whole leading edge, and the wear area of main and tail rotor blades. Blade erosion protection kits incorporating Task L-100 are now available and identified by NSN 1615-01-209-6097 and NSN 1615-01-180-2624.

During studies of rotor blade erosion on UH-60 and AH-64 main rotor tip caps at ATTC, Aberdeen Proving Ground, McDonnell Douglas' Mesa Test Facility, and Fort Eustis, AVSCOM's Directorate for Engineering produced the Task L-101 main rotor tip cap boot. Development of the tip cap boot began in 1983 and culminated in its use for prevention of sand erosion on UH-60 and AH-64 main rotor tip caps in early 1991. Blade erosion protection kits incorporating UH-60 and AH-64 protective tip cap boots are now available and identified by NSN 4920-01-334-8449 for UH-60 aircraft and NSN 4920-01-335-9380 for AH-64 aircraft.

Blade erosion protection tape kits were developed in 1989 and early 1990 by Sikorsky Aircraft and 3M for operation of UH-60 Desert Hawk aircraft in the Saudi Arabian desert environment. Testing of the tape kit materials was monitored and expanded by AVSCOM's Directorate for Engineering to encompass testing of all U.S. Army aircraft models with tape kits at Fort Eustis in mid-1990. The 3M polyurethane tape was the overall best performer in preventing rotor blade erosion during Operations Desert Shield and Storm.

Figure 2.
Flying in harsh sand environments.

The blade erosion protection kit incorporating 3M tape is now available under NSN 1615-01-328-5239.

Much of the impetus behind the development of blade erosion protection emerged from feedback obtained during previous U.S. operations and exercises. For example, Operation Bright Star was executed in the Egyptian desert environment. Although most campaigns and exercises did not last long, enough rotor blade damage was sustained to warrant research into alternative methods for flying in harsh sand environments (see Figure 2).

A combination of lessons learned and the corresponding evolution of technology accelerated the development of the U.S. Army's successful rotor blade erosion protection kits and installation instructions (Technical Bulletin 1-1500-200-20-28). During Operations Desert Shield and Storm, blade erosion protection kits protected more than $345 million worth of rotor blade assets in an environment that could destroy an unprotected blade in an average flight time of 40 hours.

Current blade erosion protection kits were developed to operate specifically in desert sand environments. Testing of these kits in other environments (i.e., rain environments) revealed less desirable performance characteristics. Therefore, future U.S. Army blade erosion technological studies may concentrate on investigating materials which could be utilized in a variety of environments not exclusive to the sand environment.

MIKE HOFFMAN is chief, Saudi Arabian Aircraft Branch in the Directorate for Engineering, U.S. Army Aviation Systems Command.

TIM RICKMEYER is an aerospace engineer, Saudi Arabian Aircraft Branch in the Directorate for Engineering, U.S. Army Aviation Systems Command.

Commanding General CECOM

MG Alfred J. Mallette

MG Alfred J. Mallette holds a B.S. degree in physics and mathematics from St. Norbert College, West DePere, WI, and an M.S. degree in operations and research analysis from Ohio State University. His military education includes the Signal Officer Basic Course, the Infantry Officer Advanced Course, the Command and General Staff College, and the Industrial College of the Armed Forces. His most recent assignments include: commander, 5th Signal Command/deputy chief of staff, Information Management, USAREUR; deputy director, Plans, Programs and Systems Directorate, Office of the Secretary of the Army, Washington, DC; deputy commanding general and director of Training Development, U.S. Army Signal School, Fort Gordon, GA; commander, 93d Signal Brigade, VII Corps, USAREUR; and commander, 8th Signal Battalion, 8th Infantry Division, USAREUR.

Missions and Organizations

CECOM has the global mission of supporting the communications and electronics equipment that U.S. soldiers have today, and providing what they will need tomorrow. This equipment is part of every weapon system and can be found throughout the world in aircraft, tanks, missiles and in the hands of individual soldiers. There are approximately 8,200 people in CECOM's workforce, most of whom are located at Fort Monmouth, NJ. Other elements are located in Virginia and Arizona.

CECOM's FY 91 budget was just over $3 billion—half of which was spent on new systems and equipment and research and development.

CECOM supports the program executive officers (PEOs) for Communications Systems, Command and Control Systems, and Intelligence and Electronic Warfare, throughout development, production and initial fielding of systems such as mobile subscriber equipment, maneuver control systems and night vision devices. Following fielding and production, CECOM readiness managers support the equipment throughout the life cycle.

At CECOM's Research, Development and Engineering Center, located at Fort Monmouth, the mission includes: managing RD&A and acquisition for tactical command, control, communications, and intelligence electronic warfare (C3IEW) systems; developing C3IEW software; supporting fielded systems and coordinating user requirements; conducting and managing technology base programs; supporting PEOs, project managers and other customers; and acting as focal point for C3IEW standardization and interoperability.

The C3I Logistics and Readiness Center, also located at CECOM, oversees worldwide materiel distribution, integrated management, repair and support of equipment, and related training. The center provides more than 100,000 types of repair and spare parts to Army field units every year. In addition, sales of equipment to more than 70 countries generated well over $2 billion dollars during FY 91.

"Budgets and programs focus on systems, but the real thrust behind C2 (Command and Control) support is the units and soldiers in the field. Research, development, design and fielding must focus on soldiers who man these systems. Only then will the system become a combat multiplier and valuable addition to the Airland Battlefield," said MG Mallette.

CECOM COMMAND GROUP

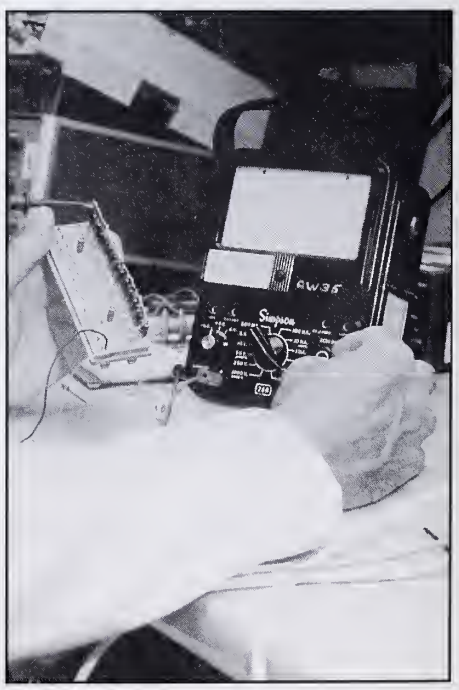
Commanding General	MG Alfred J. Mallette	Fort Monmouth, NJ
	DSN 992-2515 Comm. (908)532-1515	
Deputy Commander for Business Management		
	COL Dominic F. Basile	Fort Monmouth, NJ
	DSN 992-3559 Comm. (908)532-3559	
Chief of Staff	COL Aubrey D. Craig	Fort Monmouth, NJ
	DSN 992-3906 Comm. (908)532-3906	

CECOM CENTER FOR RESEARCH, DEVELOPMENT AND ENGINEERING

Director	Anthony Campi	Fort Monmouth, NJ
	DSN 885-2686 Comm. (908)544-2686	

CECOM COMMAND, CONTROL AND COMMUNICATIONS/INTELLIGENCE LOGISTICS AND READINESS CENTER

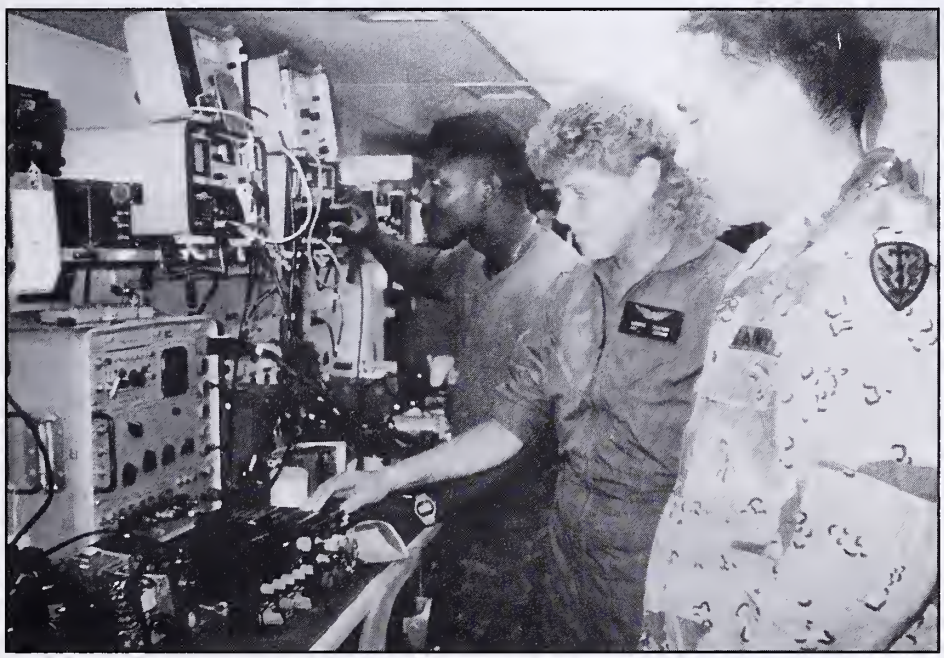
Director	James Skurka	Fort Monmouth, NJ
	DSN 992-5757 Comm. (908)532-5757	



Two examples of inventions CECOM produced for quick turn-arounds in support of Desert Storm are shown. Right, the small, lightweight test set enables instant testing of 26-pair cables to give a go/no-go diagnosis. Above, the communications system for the Lighter Air-Cushioned Vehicle-30. Both inventions went from the drawing board to prototype over one weekend, with supplies reaching the troops in one week.

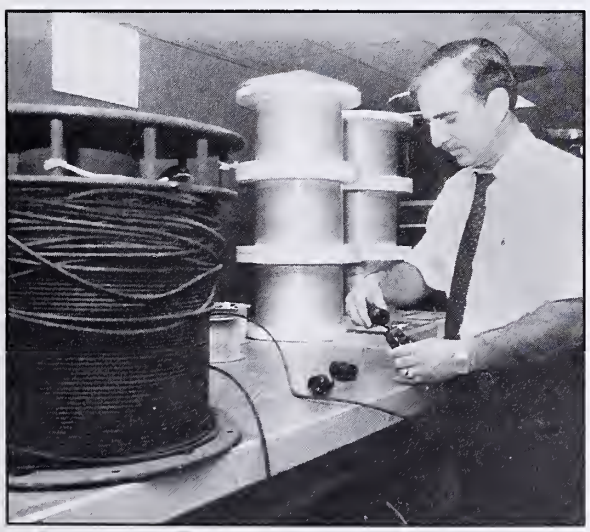
U.S. ARMY COMMUNICATIONS-ELECTRONICS COMMAND (CECOM)...

Bottom Line: The Soldier



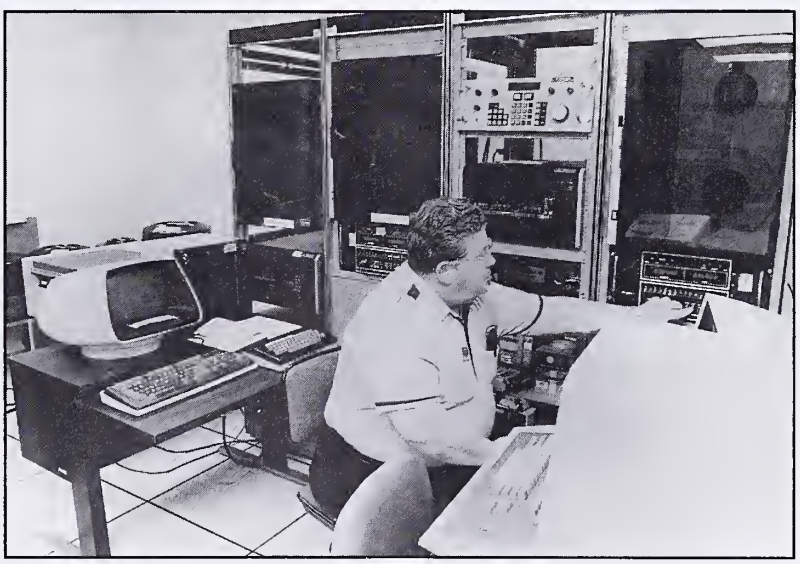
CECOM'S C3I LOGISTICS AND READINESS CENTER

The center sends logistics assistance representatives (shown left) throughout the world to provide hands-on technical support during the equipment's life cycle. These representatives were on the front lines during Operation Desert Storm. In addition, the center fields equipment, provides spare parts, trains soldiers in the use, maintenance and repair of the equipment, and provides technical documentation for repairs and maintenance.



TACTICAL FIBER OPTIC CABLE ASSEMBLY

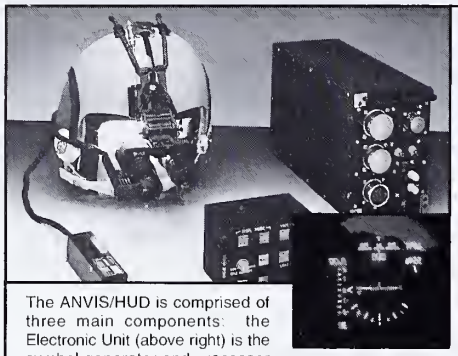
This CECOM-designed assembly, which was originally a back-up to a VHF radio as a link to Patriot Missile batteries during Operation Desert Storm, became a primary link when soldiers expressed their preference for the fiber optic link over the radio. Because it is dielectric and emanates no electro-magnetic signals, the fiber link can't be detected by enemy forces attempting to target Patriot batteries.



QUICKFIX SIMULATOR AND SOFTWARE DEVELOPMENT SYSTEM

This system was used by CECOM's Center for Software Engineering for emergency software corrections in Quickfix to allow it to interoperate with the Ground Based Trailblazer System in Saudi Arabia during Desert Shield/Storm.

PROGRAM EXECUTIVE OFFICER —INTELLIGENCE AND ELECTRONIC WARFARE



The ANVIS/HUD is comprised of three main components: the Electronic Unit (above right) is the symbol generator and processor unit. It translates data from helicopter sensors into symbols which are displayed on the Helmet Display Unit (HUD). The HUD (above left) actually superimposes the helicopter system and flight data on the ANVIS image picture. The pilot/copilot will see an image such as the photo on the right. This will allow them to view altitude, air data, navigational data, warnings and more without looking inward at the helicopter control panels. The final portion of the HUD is the Operating Control Unit (above center), which enables the pilot/copilot to operate and control the ANVIS/HUD during all types of mission execution. Fielding is scheduled to begin in FY 93.

NIGHT VISION ELECTRO-OPTICS (NVEO)

NVEO systems include a broad family of image intensification devices, thermal viewer, weapon sights, aiming lights, laser range finders, and countermeasures devices. In addition to ANVIS/HUD, shown here are the AN/PVS-7B (NVG) and AN/PAQ-4A Aiming Light on M-60 (lower left), the AN/TVS-5 Crew Served Weapon Sight (above), the AN/AVS-6 Aviation Night Vision Imaging System (ANVIS) (upper right), the AN/PAS-13 Thermal Weapon Sight (TWS) (center right), and the Mini Eyesafe Laser Infrared Observation Set (MELIOS) (lower right).

PEO-IEW

BG William H.Campbell

BG William H. Campbell received a B.S. degree in business administration in 1962 from St. Norbert College, West DePere, WI, where he was commissioned through ROTC as a distinguished military graduate. He holds a master's degree in business administration in automatic data processing from Texas Technical University. His military education includes the Infantry Officer Basic Course, the Military Intelligence Officer Advanced Course, the Command and General Staff College and the Naval War College. BG Campbell has served as the Program Executive Officer for Intelligence and Electronic Warfare (PEO-IEW) at Vint Hill Farms Station, Warrenton, VA, since November 1987. Previous key assignments include: commander, U.S. Army Field Station Kunia; commander, U.S. Army Field Station Korea; and TRADOC systems manager, All Source Analysis System. He has also served multiple tours in intelligence production, systems engineering and systems acquisition.

Management Philosophy

Asked about his management philosophy as a PEO, BG Campbell responded as follows:

"PEOs are chartered as centralized managers for assigned executive programs. They provide the leadership, vision and focus for their project managers and the myriad of agencies and commands supporting the PM. Regardless of the PEO's personal management philosophy, the first imperative is to build a team dedicated to providing the best possible support to the soldiers in the field. The total team must be committed to acquiring systems that will give our troops a generational advantage in fielded technology over our adversaries. The value of that type of advantage was demonstrated in spades in Desert Storm.

To assure we can continuously overmatch the threat, we are designing our next generation systems with an 'open systems architecture' to accommodate growth and change through technology insertion. The electronic portion of the mission equipment architecture features industry standard interfaces and protocols so we can get leverage from the commercial sector. Weapons system changes are managed as preplanned product improvements introduced to take advantage of emerging technology or to counter advances in threat capabilities. The common architecture allows us to build 'common modules' that can be developed by one PM but employed by multiple other systems. This approach requires a total team effort involving the PMs, users, tech base, testers, and logistics communities. The PEO must continually take pulse checks to assure all team members are pulling in the right direction.

We manage our programs as a 'system of systems' with the PEO taking a horizontal view across the individual systems and focusing on

IEW Common Sensor Systems

The current generation of electronic warfare, signal intelligence, and direction finding systems is being replaced with modern state-of-the- art technology, deployed on standard Army platforms. Shown here are the Advanced Quickfix on an EH-60 Blackhawk (upper right), Ground Based Common Sensor-Heavy on a Bradley chassis (above), and the Ground Based Common Sensor-Light on a HMMWV (lower right). These weapons systems use a common open systems architecture.

GUARDRAIL COMMON SENSOR (GR/CS)

GR/CS is the latest version of the Guardrail fixed wing intercept/direction finding family deployed to Army Corps. Mounted on an RC-12K platform, the system integrates COMINT, ELINT, and precision location technology on the same aircraft. The system also includes a ground processing facility linked to the aircraft by data communications and real time intelligence/target reporting capabilities. Fielding of GR/CS began in FY 91.

SMALL AEROSTAT SURVEILLANCE SYSTEM (SASS)

SASS consists of commercial ships; radar-equipped aerostats tethered to the vessels and flown at 2500 feet; and on-board mission operations facilities. SASS supports LIC requirements. It interoperates with airborne platforms when deployed.

their interrelationships and interoperability. The PMs have total responsibility for their assigned systems and execute program management tasks within broad mission guidance and architectural constraints. My preferred style is to hire the best people, get them the requisite resources, provide guidance and constraints, and then turn them loose to do their jobs. PMs by the nature of their positions are generally strong advocates for their individual systems. The PEO on the other hand must balance the resources allocated to the PMs and assure that the family of systems is managed to maximize the contribution to satisfying war-fighters' needs. This requires the PEO to conduct detailed reviews and analyses and to make the hard calls when programs get in trouble or when resources are reduced to a level where something has to be cut or deferred.

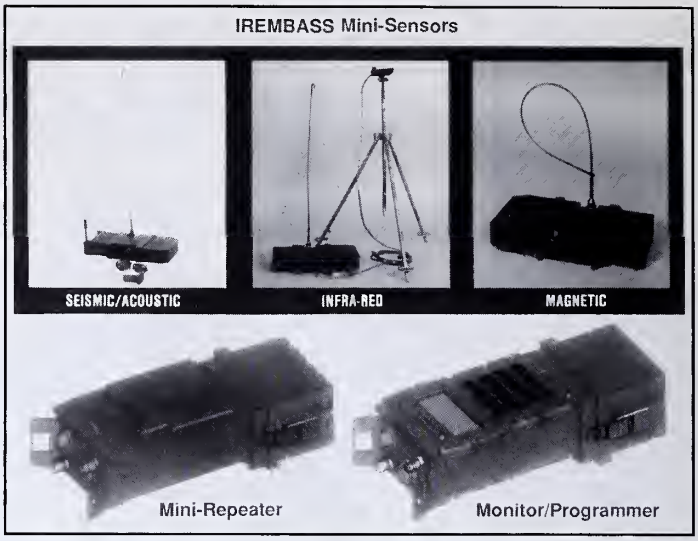
After more than four years on the job, I can report that the PEO system of intensive management is working well. In particular, PEO-IEW and CECOM have a very positive, mutually supporting relationship. But like any other approach involving humans, there's a continuous requirement to orchestrate the efforts of the total team and to keep the focus on the common goal. Things work best when everyone remembers that we're all working for the soldier in the field."

Mission and Organization

The PEO-IEW mission is to develop, acquire and field tactical systems to meet the Army's ground and airborne surveillance, target acquisition, signals intelligence, night vision, electronic warfare and weapons location requirements. The PEO organization is structured along commodity lines. Mission areas supported are IEW, close combat, aviation, fire support, SOF, and air defense.

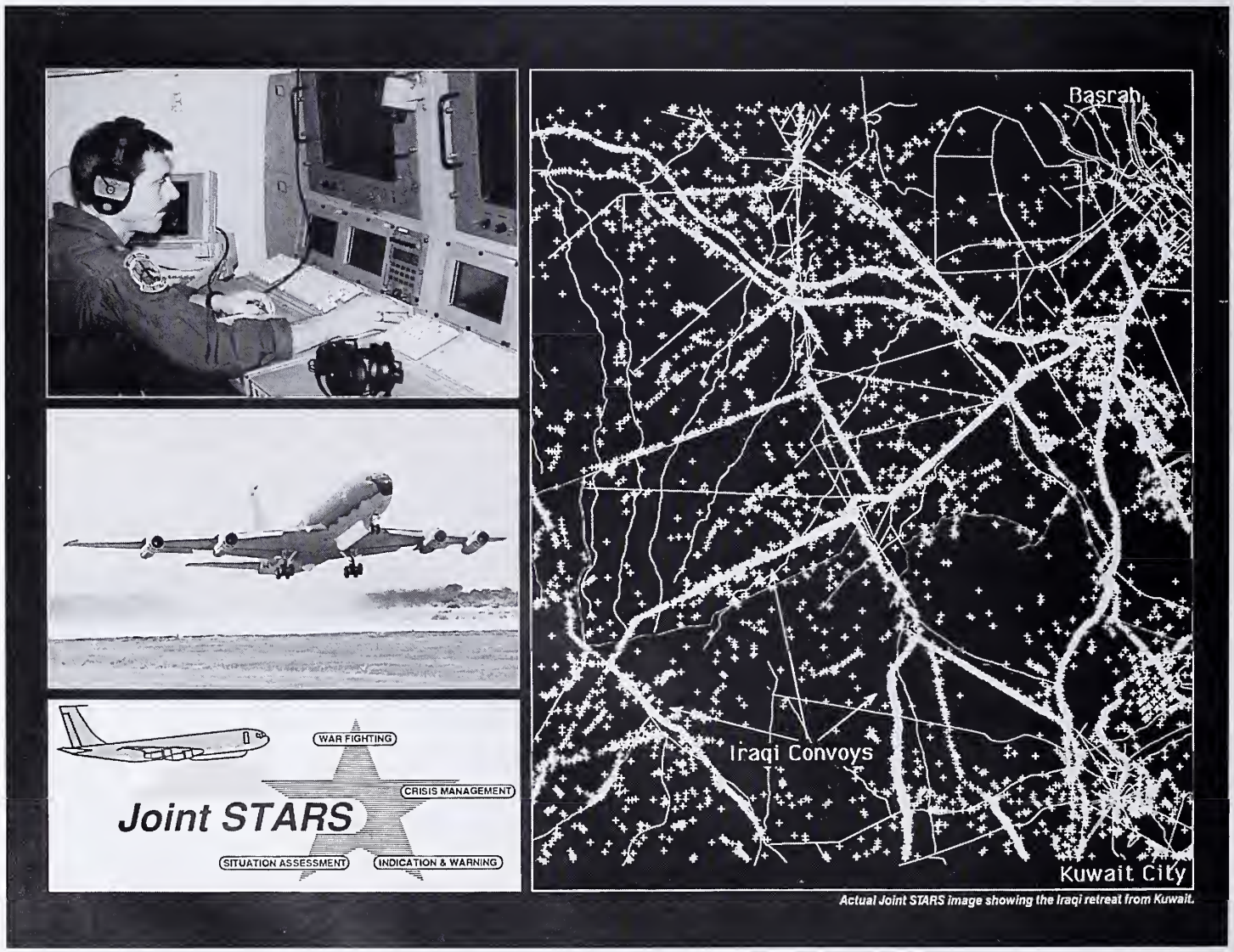
PEO-IEW HEADQUARTERS GROUP

PEO	BG William H. Campbell	Vint Hill Farms Station, VA
	DSN 229-5181 Comm. (703)349-5181	
Deputy PEO	Andrew R. D'Angelo	Fort Monmouth, NJ
	DSN 992-0179 Comm. (908)532-0179	
PROJECT MANAGERS		
Night Vision and Electro Optics	COL Martin Michlik	Fort Belvoir, VA
Signals Warfare	COL Thomas Vollrath	Vint Hill Farms Station, VA
Control and Analysis Systems	Charlie Thompson	Vint Hill Farms Station, VA
JSTARS Ground Station Module	COL James Mitchell	Fort Monmouth, NJ
Electronic Warfare/ Reconnaissance, Surveillance and Target Acquisition	COL Arthur Hurtado	Fort Monmouth, NJ
RADAR and Combat Identification	COL Peter Belch	Fort Monmouth, NJ



IMPROVED REMOTELY MONITORED BATTLEFIELD SENSOR SYSTEM (I-REMBASS)

I-REMBASS is an all weather, passive unattended ground sensor. It detects and classifies personnel and wheeled or tracked vehicles moving in the vicinity of the sensors. It then transmits real-time reports back to friendly monitors. Fielding is scheduled to begin in 1994.



Actual Joint STARS image showing the Iraqi retreat from Kuwait.

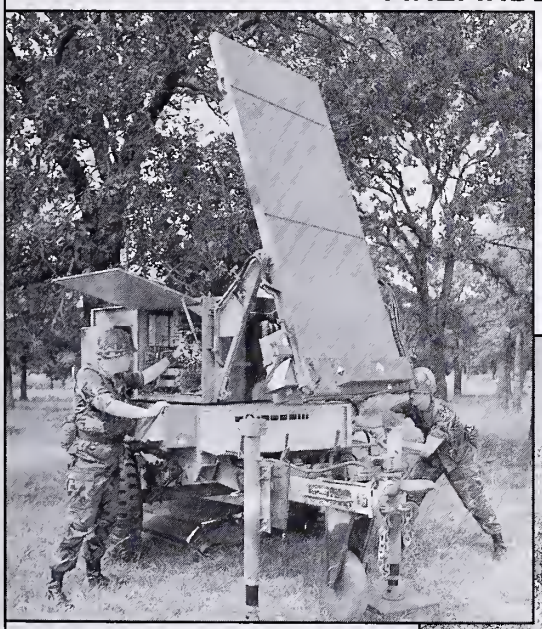
JOINT SURVEILLANCE TARGET ATTACK RADAR SYSTEM (JSTARS)

JSTARS is an Army/Air Force program. Its major components are high performance multimode radars deployed on E-8 (B-707) aircraft, a high capacity, real-time broadcast data link; and multiple ground station modules which provide real-time radar data to ground commanders and their staffs. JSTARS provides continuous wide area coverage of surface targets and serves the ground component commander in much the same way that AWACS serves the air component commander. The GSM will also interoperate in real time with UAV's and other sensor platforms.

AN/VLQ-7
STINGRAY COMBAT PROTECTION SYSTEM

STINGRAY is an electro-optics, countermeasures system deployed as an adjunct to the Bradley Fighting Vehicle. The system is currently in Engineering and Manufacturing Development.

FIREFINDER

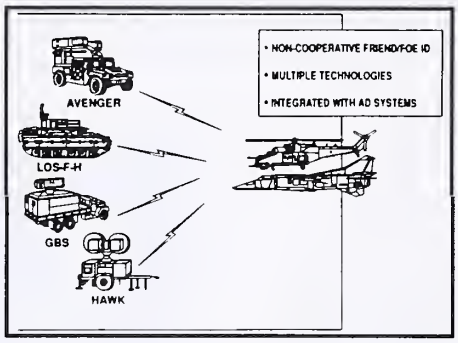


AN/TPQ-36 MORTAR LOCATING RADAR
(shown below)

FIREFINDER is a countermortar/counterbattery radar fielded in two variations—AN/TPQ-36 and AN/TPQ-37. The AN/TPQ-36 is currently being upgraded through product improvements. Plans are being developed to replace the larger AN/TPQ-37.

AN/TPQ-37 ARTILLERY LOCATING RADAR
(shown above)

During Desert Storm, PEO IEW initiated the development of new software for the AN/TPQ-37 which would allow the system to acquire long range targets such as SCUD and FROG missiles. PM FIREFINDER, along with CECOM Center for Software Engineering and CECOM Center for EW-RSTA accomplished the development and fielding in less than 45 days.



NON-COOPERATIVE TARGET IDENTIFICATION TECHNOLOGIES (NCTR)

Shown above are air defense weapon platforms with NCTR. PM Radar is responsible for the Ground Based Sensor (an air defense radar) and multiple NCTR devices that will be integrated on air defense systems.

DESIGN TO REDUCE HUMAN ERROR

By Dr. Paul J. School

Introduction

Human error is a behavioral oddity that is like stumbling over our own feet. We do not intend to do it and we wonder why we did it. Often, we do it again.

Design causes some human error. That is, design got in the way; so, people blundered. With proper cognizance of the problem we can reduce error.

Human Error

A General Accounting Office (GAO) report (PSAD-81-17, January 1981) said human error caused 20 to 40 percent of the unreliability experienced with nine missile systems. That report added, human error caused 63 percent of ship collisions, floodings, or groundings. The GAO summarized: "We estimate that human errors account for at least 50 percent of major system failures." The report concluded that we have the knowledge and the means of application to reduce human error.

People make errors for many reasons. Some of those reasons escape control, but the majority can be controlled. The place to begin is proper regard for human error.

Sometimes, human error is asserted when the root cause lies deeper. To illustrate: A highly experienced pilot made the over-water approach at San Francisco. The sun was bright, visibility was excellent, the bay was supercalm. The huge stretch jet moved gradually down its 2.5 degree glide path and landed softly in the San Francisco Bay.

Luck prevailed, the plane rested high and mostly dry on two oyster beds. The passengers first learned of their dilemma when they noticed a small sailboat drift past the huge aircraft.

An investigation concluded pilot error when the captain accepted blame. Disturbingly, other stretch jets crashed under similar circumstances at Boston and again at Miami.

Highly experienced pilots landed stretch jets short of runways, in very calm water, when flying conditions were superb. Pilot error was again and again said to be the cause. True, the pilots landed short of the runways, but was their error the basic cause? The coincidence of circumstances aroused doubt.

Further investigation determined the root cause of the pilot errors. The leisurely glide slope of the aircraft combined with approaches over calm water—which reduced visual cues—deprived the pilots of an appreciation for their rate of descent. The pilots landed in the water because they probably did not realize the danger until it was too late to do anything. Knowing this, the investigators told stretch jet pilots to use the glide path instrument, not their judgement.

To recap: Operator error was an accepted explanation for the incidents. Then, the investigators realized they should dig deeper. Deeper investigation found the root cause to be training error rather than operator error. Thus, the error was not solely the pilot's.

> *Assertions of operator error suggest nothing could have been done to prevent the error; therefore, nothing may be done. That can lead to recurrence of the incident.*

Pronouncements of human error follow most well-publicized tragedies such as Three Mile Island or Bhopal, India. There seems to be a relationship between the magnitude of the disaster and the persistence of the human error declaration.

We need to be more circumspect about assigning cause. Did the user commit the root error, or did those who designed the software and hardware fail to recognize something important?

Sometimes operator error is an inescapable conclusion. Humans get into trouble due to irrational moments or lapses of attention. In other words, humans act human. Discourse must move beyond and design must recognize that plain fact. The real issue is: What can be done to keep our imper-

fections from wrecking systems?

What Can Be Done?

Resigned acceptance of human error deserves skepticism. Human error should be a red flag that prods investigation of cause. Human error does not deserve the status of an explanation unless that conclusion emerges as the root cause. Otherwise, human error is only part of the truth. Partial truths can lead to recurrence, as happened with the stretch jets.

We must become skeptical of accepting general terms as sole explanations. Human error only says that a human made an error. Human error does not address why the human made the error; thus, the path to correction is vague.

There are many elemental causes of human error. The following were chosen because they are frequent and generic. The list is not comprehensive: carelessness; failure to follow procedures; design-induced error; design that requires over-dependance on recall; design which can, but does not evoke proper behavior; human capability is exceeded.

Carelessness as well as failure to follow procedures are improper behaviors. Such behavior is a management problem handled by training or personal control.

People don't always follow procedures, but it is hard to imagine that whim is a significant reason for major system failures. The selection process for most airline pilots, ship captains and nuclear reactor operators is rigorous. They are trained extensively. Most of them recognize their responsibility and they do not act impulsively. Managers can stress awareness of procedures, hazards and risks, but little more can be done about improper behavior.

Design is preferable to admonishment. Training is a poor second to design. Design endures, training may not. Inadequate system design and situational factors can cause human reliability to decline. People can be set up to mess up. Design is a controllable determinant of human-machine reliability. What should we look for in design?

Reduction of complexity is a good start. Many designs include nice-to-have gauges, knobs, and switches located near the most used controls. Those designs provide the user more choice than needed. For instance, many home appliances such as dishwashers have buttons that do not get pushed after the first month of use.

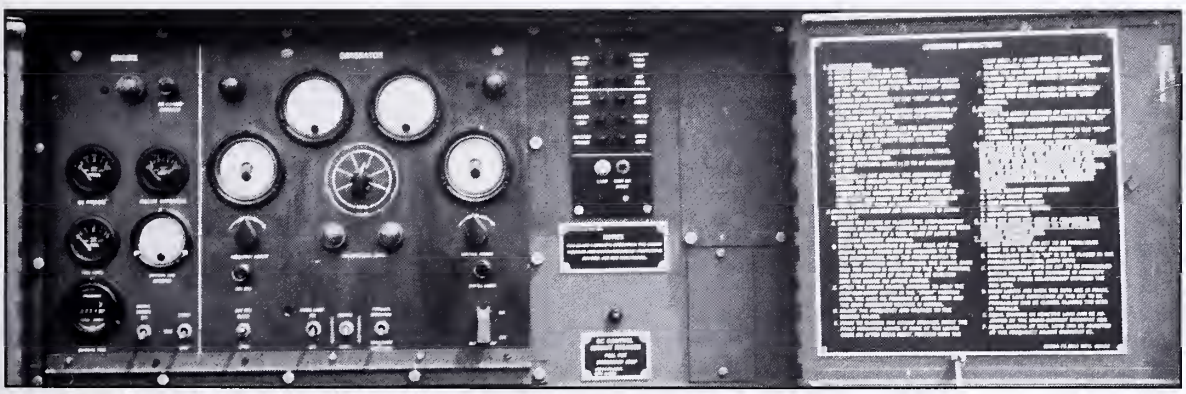
More controls placed at the primary control location provide flexibility of operation. On the other hand, the more we make readily accessible, the greater the chance of error.

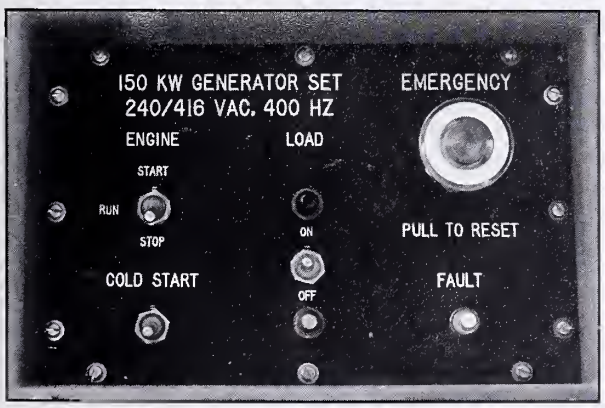
Each design decision must optimize system performance. Nice-to-have items can usually be located away from the primary operating controls or deleted with small sacrifice of typical system performance. Designers should ask: Why have that? Why have it there?

An unwritten rule is: Whether or not adjustment is appropriate, if users can adjust it, they will. The unwritten corollary is: If it should not be adjusted by users, move it to where they cannot find it. That is one reason TV sets in motels do not have front panel adjustments any more.

The KISS (Keep It Simple Stupid) principle of design must become a decree. Complicated designs cause problems that lead to user rejection. Simple designs, like the paper clip, enjoy wide use for decades. Few designs can be paper clip elegant, but many designs can be simplified.

Figure 1 shows the Military Standard Generator Set control panel. It has 36 knobs, gauges, etc., and 535 words of





Above (Figure 1.) is the Military Standard Generator Set control panel with 535 words of operating instructions to the right. Left (Figure 2.) is the Improved Generator Set Control Panel—"To get power, turn it on."

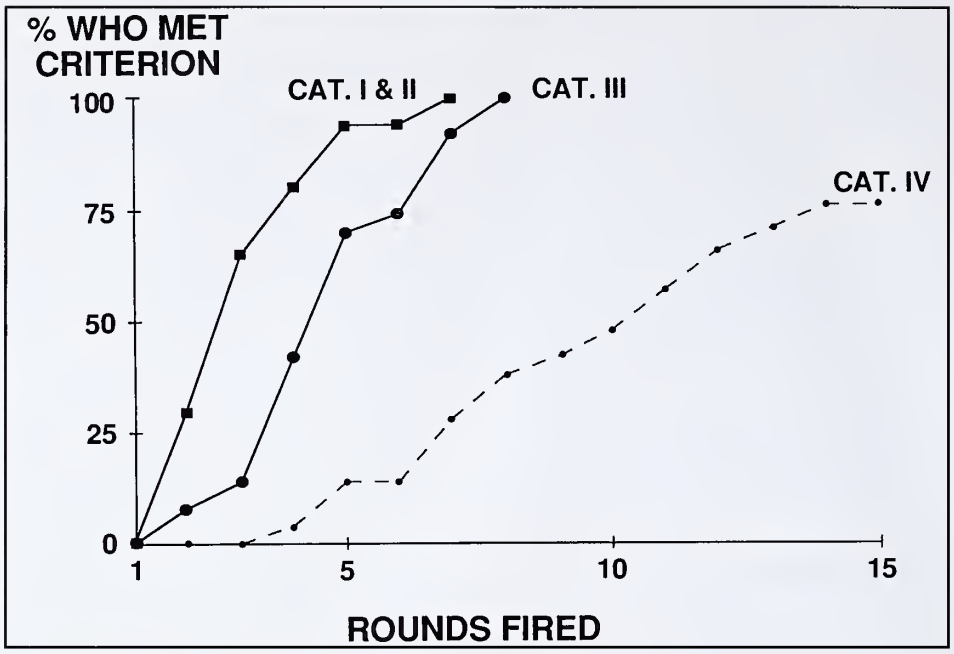


Figure 3.

operating instructions. Operators require days of training.

Current technology allows us to eliminate most of the panel components. The Belvoir Research, Development and Engineering Center and the Human Engineering Lab Detachment developed a prototype 7-component panel for the 150 killowatt generator set (see Figure 2). With only a "turn it on" instruction, numerous adults and children started that large set.

There is nothing new about designing to control user behavior. Cars will not start unless the lever is in park or neutral. Microwave ovens turn off when the door is opened. Gas is not supplied to furnace burners unless the ignition source is on. Those are good ideas; we need more like them.

Good design is the investment that heads off trouble at the drawing board. Training is done many times, use happens every time. If design forces correct behavior and frees up the operator's attention, errors are less likely and less training is required.

Some designs provoke error by requiring too much user knowledge and recall. Computer software and manuals are an example. Many computer cognizant people do not design software that is oriented to unsophisticated users.

There is a commercial program that uses the word 'quit' in three ways: exit after saving, move back one screen, or exit without saving. That program forces users to remember where they are and associate that with what is going to happen. Such software confronts non-rocket scientists with a modern frustration: Software self-entrapment.

Software self-entrapment starts bad and usually gets worse. It begins with: I don't know how I got here. It moves to: What can I do about this? The problem grows to become: I'd better do something that gets me out of this. Then, a silicon trap imprisons the user. If software was written better, users would know where they are and how to move about. Users would not be snared by silicon. Users are friendly and software should reciprocate.

Users can be set up for error by designs that do not evoke correct behavior. People deal with typical objects or actions in typical ways. We bring a map-like set of anticipations to most tasks. We acquire the map because objects are usually arranged in a typical manner and most interactions occur in a typical manner.

Power boats with steering wheels like cars were introduced several years ago. Those steering wheels turned the boat like a tiller. Turn left to make the boat go right. Several accidents proved that design decision wrong.

Violations of user anticipations increase probability of human error. As an experiment, try to communicate a phone number in this manner: "17 billion, 36 million, 5 hundred and 57 thousand, 3 hundred and 34". Confusion will reign.

Confusion caused by poor design does reign. Each of six commercial computer programs uses a different key to do a save; each uses a different key for an exit. The user must deal with 12 program specific ways to perform those commonly needed functions. People who move from one of those programs to another make errors. If typing "save" executed a save and typing "exit" did an exit with a "do you want to save" reminder, errors would decline.

Designs must fit user capabilities (see Figure 3). A missile system was designed for use by Category I&II soldiers. The left curve is Category I&II soldier performance. They required seven rounds to meet the criterion. In tests, Category IV soldiers fired the missile. They required 15 rounds and only 75 percent of them achieved success.

Therefore, if Category IV soldiers are assigned to that system many more rounds will be fired in training, or we must redesign the system to make it Category IV compatible.

Conclusion

The percentages of human error described by the General Accounting Office are as typical as they are unacceptable. Those percentages need not be the norm. The message is: Preclude undesirable behaviors and force needed behaviors via design to decrease human error.

If design is done with the human in mind, then humans would have less error on their minds. We have the standardization documents and the subject matter experts to convey human factors knowledge to designers. We can design to match human psychological, physiological, and physical capabilities. Humans will co-exist with technology; so, we must practice human oriented design.

PAUL J. SCHOOL is chief of the Human Engineering Lab Detachment at Fort Belvoir. He is an adjunct assistant professor at The Uniformed Services University of the Health Sciences, and holds Ph.D. and M.S. degree in physiological—experimental psychology from Case Western Reserve University.

FIGHTING CORROSION WITH TECHNOLOGY

Introduction

The Army spends a staggering $300 million annually to repair corrosion damage at installations. Fixing corroded civil works structures costs another $100 million each year.

The U.S. Army Construction Engineering Research Laboratory (CERL) in Champaign, IL, is working to reduce the high cost of corrosion through a research program that exploits and develops innovative technologies. The diversity of this research is necessary to tackle a problem as pervasive and complex as corrosion. Among the areas being investigated are protective coatings, cathodic protection, nondestructive test methods, and computer technology to analyze corrosion status and manage repair budgets. This article summarizes examples of CERL's efforts in corrosion mitigation research.

Pioneering Research: The Ceramic Anode

Any metal structure can corrode over time, but certain conditions accelerate the problem. Especially vulnerable are structures buried in soil, such as distribution pipes and underground storage tanks, and the water-side surfaces of water storage tanks and lock and dam gates. Corrosion of these structures can cause system failures, costly maintenance, environmental hazards from leaks (i.e., if the structure holds petroleum products), and safety threats such as gas leaks.

Cathodic protection (CP) has been used for many years to mitigate corrosion on metal structures. CP systems prevent corrosion by applying a small electric current from an outside source to the vulnerable structure. The current is impressed through an anode, which disintegrates over time as it is consumed in the process.

By Dana Finney

In the past, most anodes were made of graphite or a silicon-iron alloy. Both materials are brittle and are consumed very quickly in the CP system. Because of the high consumption rate, the anodes had to be massive to avoid frequent replacement. The anodes' mass made them vulnerable to damage from debris and ice; moreover, they were difficult to install, which often introduced electrical shorts in the system. These problems reduced the Army's CP system reliability to an average of 50 percent.

CERL developed an electrically conductive, ceramic-coated anode in 1983 as an alternative to the traditional anodes. The material comprising the ceramic-coated anode is consumed at a rate 500 times less than graphite and the silicon-iron alloy. As a result, this anode is much smaller and lighter—more than 10 times by weight—yet has the same service life of 20 years. Besides being smaller, the anode can be configured in different shapes; these properties allow anodes to be installed in areas previously inaccessible with the graphite and silicon-iron alloy anodes. The ceramic-coated anode also has a self-healing electrical connection that prevents anode-to-electrical lead wire failure.

The ceramic-coated anode was demonstrated at three sites in 1988 under the Facilities Engineering Applications Program (FEAP). The demonstrations involved an elevated water tank at Fort Hood, TX, five water heaters at Fort Lewis, WA, and an underground storage tank at Fort Lee, VA. At these sites, the anodes have continued to provide complete cathodic protection with no major operation or maintenance problems. Results of the demonstration were used to prepare a Corps of Engineers Technical Letter, ETL 1109-10 9FR), *"Cathodic Protection Systems Using Ceramic Anodes"* (5 January 1991).

APS Materials, Dayton, OH, holds the exclusive license for the ceramic-coated anode developed by CERL. This company markets it commercially under the trade name CerAnode. Other manufacturers have developed their own versions of ceramic anodes and are supplying them under various trade names.

CP Diagnostic Troubleshoots, Keeps Records

CP systems must be monitored and maintained properly to ensure their effectiveness. The Environmental Protection Agency (EPA), through 40 CFR, parts 280-281, and Army Regulation 200-1 both require monitoring of CP systems used on underground storage tanks (USTs) that contain regulated substances (such as petroleum products). In addition, the Department of Transportation (DOT) requires recordkeeping on CP systems that protect underground gas pipes (49 CFR, parts 191-192).

Monitoring CP system performance involves testing, recording, compiling, storing and evaluating a large amount of data—a very time-consuming process. The data must be interpreted properly so that malfunctioning systems can be pinpointed and repaired. Failure to repair a faulty CP system can eventually result in leaks to the pipes or tanks that were supposed to be protected.

CERL developed the CP Diagnostic computer program to help facility engineers analyze, store, and organize data from CP systems. It can also determine which areas of the system are not meeting the criteria for effective cathodic protection. CP Diagnostic includes

CP system inspection data can be entered easily using a portable notepad-type computer that recognizes handwriting.

programs for both the sacrificial and impressed current types of CP and uses artificial intelligence programming.

The program stores two types of information on the CP system: background and field measurements. Background information for the protected structure includes the identification and location, date of installation, physical description, contents of the pipe or tank, and soil properties (for buried structures). A diagnostic tree is programmed in Prolog language to assist in troubleshooting and maintenance. Background on the CP system also is stored.

Field measurements are taken during inspections and entered into the data base later. Both programs store data such as structure-to-soil potential, anode current output, and isolation joint condition. The impressed current program also stores rectifier readings, such as input and output voltage.

CERL has developed an interface with a commercially available notepad computer. This small computer is very useful for collecting and storing field data. CP Diagnostic is loaded into it to bring up inspection "forms" on the computer's screen. Inspectors use an attached stylus to write in measurements as they are made. The computer notepad recognizes handwriting so that, as the inspector records data, the computer converts it to typeface letters and numbers, and enters it on the appropriate line. Back at the office, the inspector connects the portable computer to the microcomputer housing CP Diagnostic and the inspection data is downloaded automatically.

CP Diagnostic contains five criteria defining conditions for cathodic protection. These criteria are industrial standards and include those recommended by the National Association of Corrosion Engineers. The program automatically compares the field measurements with these criteria and produces a trouble report showing areas not in compliance. It generates several other useful reports, some of which can be used to meet EPA and DOT reporting requirements.

The CP Diagnostic system was demonstrated during 1989 and 1991 at Fort Hood, TX, under FEAP. The 1989 application was for an impressed current CP system on gas distribution piping. In 1991, Sacrificial CP Diagnostic was used on a system protecting an underground tank farm that stores jet fuel. The sacrificial program also was tested in 1989 on a gas distribution system at Fort Riley, KS.

Using CP Diagnostic, both Fort Hood and Fort Riley identified several areas where pipes and tanks were unprotected. The system pinpointed problems that the installations had known about previously.

Robotic Pipe Inspection

One reason corrosion costs so much is that problems are difficult to detect at an early stage, when they are less expensive to correct. Corrosion often progresses until the structure fails, requiring costly repairs or replacement.

Inspecting pipes for corrosion usually has involved destructive procedures. That is, the only way a pipe's condition could be assessed was to dig it up (or tear into building walls and floors), then cut out "core samples" to see inside. This type of testing bears a high cost and has had to be weighed against simply repairing leaks as they occur.

CERL is developing a pipe inspection "crawler" that will allow easy, nondestructive testing of 2-inch-diameter pipes. The system uses a small robotic device that carries an optical video probe and corrosion sensors. As it crawls through the pipe, the device sends electronic images to a video processor, which transform and displays them on a monitor. The operator can detect corrosion in real time, or data can be recorded and examined later using spreadsheet and analysis software.

The pipe inspection crawler will save money in several ways. It will avoid costly destructive assessments and allow corrosion to be detected while the problem is still small. The crawler will also eliminate the high cost and inconvenience of lengthly system shutdowns. And because it will be easy to

use, inspections can be done frequently to make sure the pipes remain corrosion-free.

CERL is bench testing the prototype pipe inspection crawler with several different sensors, such as electrical capacitance and laser proximity sensors. Sensors for detecting scale are being developed for use with the crawler. A field test is scheduled during FY 92, with a demonstration planned for FY 93.

Another corrosion monitoring technology developed at CERL has been patented. The Pipe Corrosion Monitor uses electrochemical polarization decay (time domain) and can assess the condition of underground coated pipes and other steel structures. Currently, laboratory and field tests are being conducted in the frequency domain, as well. This technique has potential application in determining the condition of coatings on underwater structures such as miter gates without dewatering.

Corrosion and Scaling in Heat Exchangers

The Army makes wide use of domestic water storage heaters to supply potable hot water to large buildings such as hospitals, barracks, and offices. When the tube bundles in these heaters are placed in corrosive environments, they begin to corrode and erode, eventually developing leaks. When located in scaling environments, these bundles lose their heat transfer efficiency due to scale build-up on the potable water-side surfaces of the tubes. Both conditions bring high maintenance and repair costs, as well as inconveniences to building occupants.

Protective coatings have been used for many years in industrial applications to prevent corrosion and scale formation on metals exposed to harsh environments. Bake-on phenolic (thermosetting resin) coatings have successfully prevented corrosion and scale on nonferrous metals and alloy steels exposed to river, sea, brackish, and circulating cooling water. However, this coating was not originally developed for use in domestic water systems.

CERL worked with the coating's manufacturer to modify the baked-on phenolic coating to reduce scale and corrosion of copper tube bundles in potable water heat exchangers. The main difference between the modified and original systems is the addition of a clear, non-pigmented top coat, which produces a clear, glossy finish. This coating is highly resistant to corrosion and scale. The Surgeon General has approved the modified coating system for use on potable systems.

The coating was first demonstrated under FEAP for a scaling problem at Fort Hood in 1986. Severe scale build-up in heat exchangers serving two dining halls had required Fort Hood to acid-clean the copper tube bundles every 60 to 90 days. In this demonstration, CERL cleaned the tube bundles and applied the modified baked-on phenolic coating. Since 1986, no acid cleaning has been necessary. The payback for this application was one year.

In addition to restoring heat transfer efficiency to the heat exchangers, the coating has had a significant environmental benefit: it eliminates the need for handling and disposal of the strong acids used for cleaning.

A more recent FEAP demonstration started in 1990 is showing the coating's ability to prevent corrosion. At Fort Lewis, WA, heat exchangers are fed by steam and high-temperature hot water. Because the water supply has a very low alkalinity, tube bundles undergo two types of failure: erosion on the outside and galvanic corrosion on the water side. CERL coated both sides with the phenolic coating. Data collected from Fort Lewis to date indicates that the coating is performing successfully. The projected payback at this site is one year.

Maintenance Management Systems

Buried pipes at Army installations total more than 3,000 miles. Many of these pipe systems are deteriorating and require repair or replacement to continue functioning. However, managers face a complex task in making sound maintenance decisions. To allocate scarce funds optimally, they have to consider factors such as duration and effectiveness of a repair and whether replacement would be more cost-effective. These factors are "unknowns" and must be predicted mathematically.

CERL is developing three computerized management systems to help mangers choose among maintenance and repair (M&R) options. G-PIPER supports decision-making for gas pipes, W-PIPER is designed for water distribution pipes, and SCALAR is intended for potable water pipes in buildings. G-PIPER has been demonstrated at Fort Hood under FEAP.

These systems use mathematical models in conjunction with a Corrosion Status Index (CSI). They calculate the CSI from information such as pipe wall thickness, soil properties around buried pipes, water chemistry, operating temperature and pressure, age, pipe material, and so on.

The systems predict the first year a pipe will leak and the number of leaks it will have in following years, thus projecting economic service life. They also determine when the pipe system (or a certain section of it) will no longer meet fire flow or daily demand requirements. These predictions help managers make informed decisions for M&R budgeting.

All three maintenance management systems are designed to be user friendly. Besides helping with resource allocation, they are useful in designing water systems for retrofits or new construction: the same information used in making M&R decisions can be considered in assessing the life-cycle costs of different design options.

Summary

Advanced materials and designs could someday eliminate corrosion of pipes and tanks. Meanwhile, millions of metal structures are in place and must be protected to remain functional and environmentally safe. The innovative technologies just described are successfully mitigating corrosion and managing M&R programs.

For more information on USACERL's Corrosion research, contact Dr. Ashok Kumar, USACERL Engineering and Material's Division, P.O. Box 9005, Champaign, IL 61826-9005, Commercial (217) 373-7235, or Vince Hock, Commercial (217) 373-6753.

DANA FINNEY is a public affairs specialist in the Public Affairs and Marketing Communications Office at CERL. She has been with CERL since 1983 and twice received the Secretary of the Army's Editor of the Year Award—in 1987 and 1989. She has a B.A. in science writing and editing from the University of Illinois at Urbana-Champaign.

A NEW STRATEGY FOR FASTER FIELDING OF SOFTWARE-INTENSIVE SYSTEMS

By Dr. Margaret E. Myers

Introduction

As program managers wrestle with the problem of how to build systems better and faster in an era of shrinking DOD budgets, many have begun to explore the concept of dividing a system into blocks for development, testing, and fielding. (A block is a subset of a total system that by itself provides stand-alone functionality or integration capability with other systems.) This is especially applicable to software-intensive systems, which require costly labor-intensive debugging and verification.

The Operational Test and Evaluation Command (OPTEC) recently took a hard look at software-intensive system operational test and evaluation (OT&E) strategy to see if there might be a better way to do business. This analysis resulted in development of the new, flexible strategy described here. This strategy applies to both materiel systems with extensive embedded software and information mission area systems.

Traditional weapon system OT&E requires the entire system to successfully complete OT&E of production-representative items before fielding (Milestone III). The new OT&E strategy allows partial fielding of software-intensive systems, once successful OT&E of a representative sample has been accomplished. A representative sample is the portion of the software to be developed that demonstrates the ability of the hardware, commercial off-the-shelf (COTS) software, and communications network to support the total system requirements.

Milestone III.n Approach

The keystone of the new OT&E strategy is the Milestone III.n approach shown in the accompanying illustration. (The timeline in the illustration begins after Milestone II.) If a system has a hardware and COTS software component (operating system, communications software, data base management system, query language, etc.), OPTEC will conduct a limited user test (LUT) to determine successful interoperability of the hardware and off-the-shelf software and its interaction with users (soldiers) and the operational environment.

A test bed must be configured and fielded to support the LUT. Authorization to purchase and field the LUT test bed occurs at Milestone II or, in cases where the design is incomplete, on approval (by Army or DOD, depending on the level of oversight) of the OPTEC LUT test and evaluation plan.

Following a successful limited user test, OPTEC will redefine the test bed for the Initial Operational Test and Evaluation (IOTE) of block 1 of the developed software and will recommend fielding additional hardware and off-the-shelf software to appropriate sites beyond those required for the limited user test. The operational test bed may increase in size to support testing of subsequent (1 through n) blocks of developed software.

Representative Sample

Each block of developed software must provide added functionality or necessary integration capability with other systems and must stand alone, in the event that subsequent blocks are never fielded. OPTEC will conduct an Initial Operational Test and Evaluation for each block. When a representative sample of the total software functionality to be developed has successfully completed operational test and evaluation, OPTEC will provide a fielding recommendation to the Milestone III.C (fielding certification) decision review.

To reach a representative sample, some number of blocks must sufficiently stress the hardware, off-the-shelf software, intrasystem connectivity, and communications network. Definition of a representative sample will differ for each system.

Generally, the representative sample will be determined by collating the critical mission functions from the requirements documents with the hardware and off-the-shelf software capabilities.

Fielding Follows Milestone III.C

DOD (or Army) approval at Milestone III.C will allow the Army to authorize purchase and fielding to all users of 100 percent of the hardware and off-the-shelf software and all developmental software successfully tested to date.

OPTEC will conduct additional Initial Operational Test and Evaluations for software blocks developed after Milestone III.C. Each block may be fielded after successful IOTE. For each IOTE and the limited user test, OPTEC will prepare an operational assessment. When the final block has completed Initial Operational Test and Evaluation, OPTEC will provide an Independent Evaluation Report to address the total system's operational effectiveness and suitability.

The jagged vertical line in the illustration can move to the left or right, depending on the definition of a representative sample of the blocks of software to be developed. Many systems will have no more than one or two blocks; some may have several; regardless of the design, the OT&E strategy can be tailored to support the development and fielding strategy.

CMFs, IOTE Readiness Criteria, and Tripwires

Other features of the new strategy include: the addition of critical mission functions (CMFs) to Part I of the Test and Evaluation Master Plan (TEMP) (CMFs are those functions that represent the minimum acceptable functionality of a system or incremental block of the system.); criteria for determining readiness for IOTE; and tripwires to determine IOTE requirements when changes are made to the critical mission functions, hardware, off-the-shelf software, or the communications network. An IOTE tripwire is a criterion that, if met, requires OPTEC to determine whether IOTE is necessary for post-deployment software support (PDSS) testing.

CMFs are developed and prioritized by the user representative and are based on the user's requirements. They are grouped into and enabled by blocks of developed software. An example of a critical mission function for a weapon system might be to provide position location; an example for an Information Mission Area system might be to process officer promotions.

As part of OPTEC's strategy for successful fielding of software-intensive systems, IOTE will not start without some assurance that the system can successfully function in the operational environment. In addition to the standard operational test readiness statements from the PM, user representative, technical tester and evaluator, and operational tester and evaluator, OPTEC will require the Configuration Control Board (CCB) to certify that each block is ready for test.

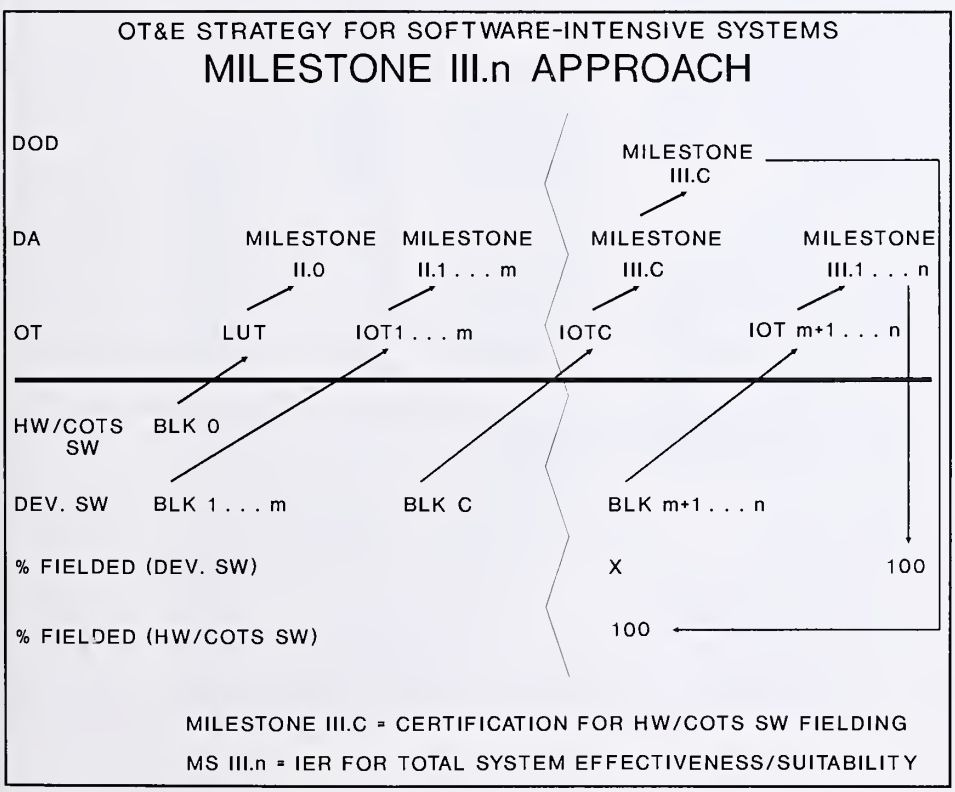
OPTEC also has a new requirement to consider testing of changes to blocks and systems after fielding. If one of the following three tripwires is activated, the CCB is required to notify OPTEC: significant impact on or change to CMFs; a computer resource change that affects system operation or supportability; or changes to more than 15 percent of the software. After examining the changes to be made, OPTEC will determine whether a new Operational Test and Evaluation is required. Otherwise, normal PDSS testing will occur.

Policy Status

The new OT&E strategy is consistent with DODI 5000 and 7920 series, including the recent DODI 5000.2 LRIP change from Milestone IIIA to II. The strategy also implements the Software T&E Panel (STEP) recommendations for a unified software process. Implementing policy has been approved by the deputy under secretary for operations research and will be incorporated into AR 73-xx and DA PAM 73-xx.

Conclusion

The new OT&E strategy supports multiple software development methodologies, to include older approaches and newer rapid prototyping and development concepts. This approach is flexible, enhances the program manager's acquisition strategy, and reduces the risk to the soldier and decision maker. OPTEC will work with program managers to tailor the strategy for each system.



DR. MARGARET E. MYERS is director for Information Mission Area Systems Evaluation, U.S. Army Operational Evaluation Command, an OPTEC subordinate command. She has a B.A. in mathematics from Colorado College, a M.S. in operations research from American University and a Ph.D. in information technology from George Mason University.

ARMY DISPLAYS DESERT STORM NIGHT VISION TECHNOLOGY

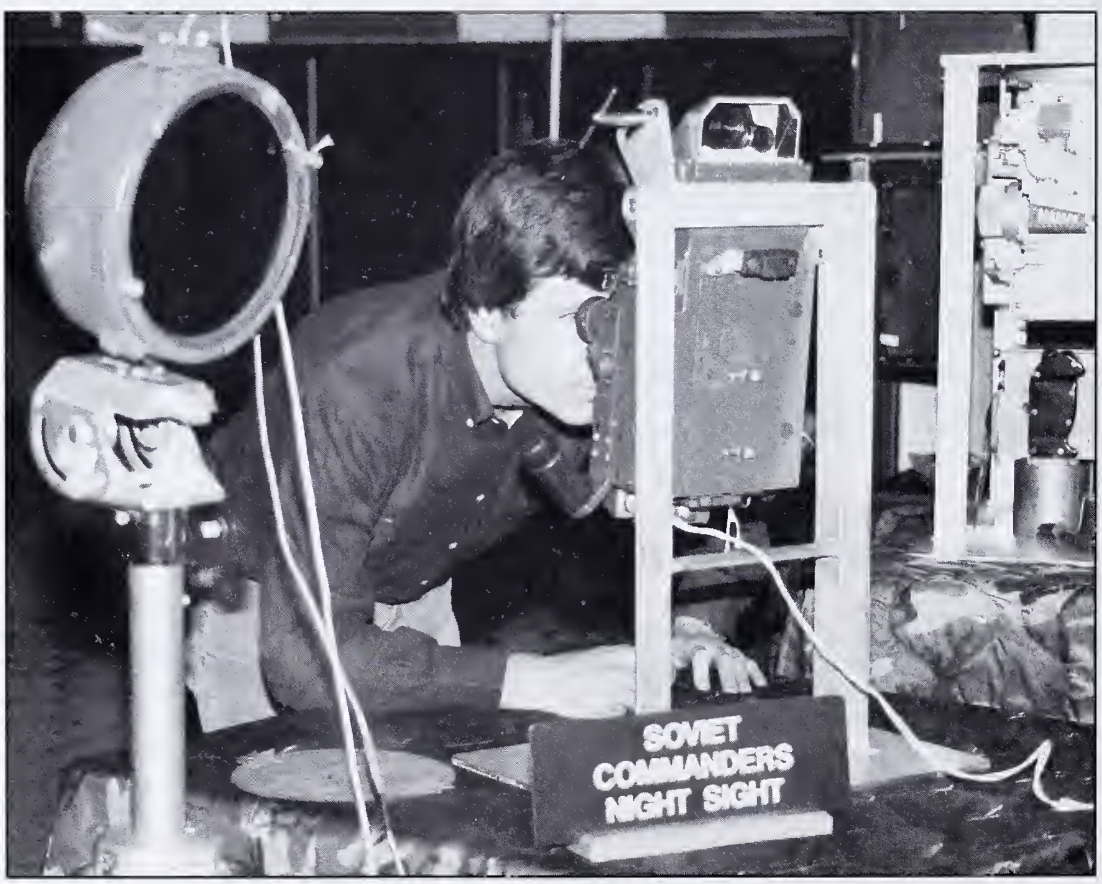
By Martha McCaslin

Payoffs in R&D are sometimes difficult to measure. Not so in the case of night vision technology. Recent events in Southwest Asia brought to the nation's attention the U.S. superior ability to "see" the enemy in any weather, day or night. General H. Norman Schwarzkopf wrote, "The night vision devices provided to our forces gave them a significant advantage over the enemy."

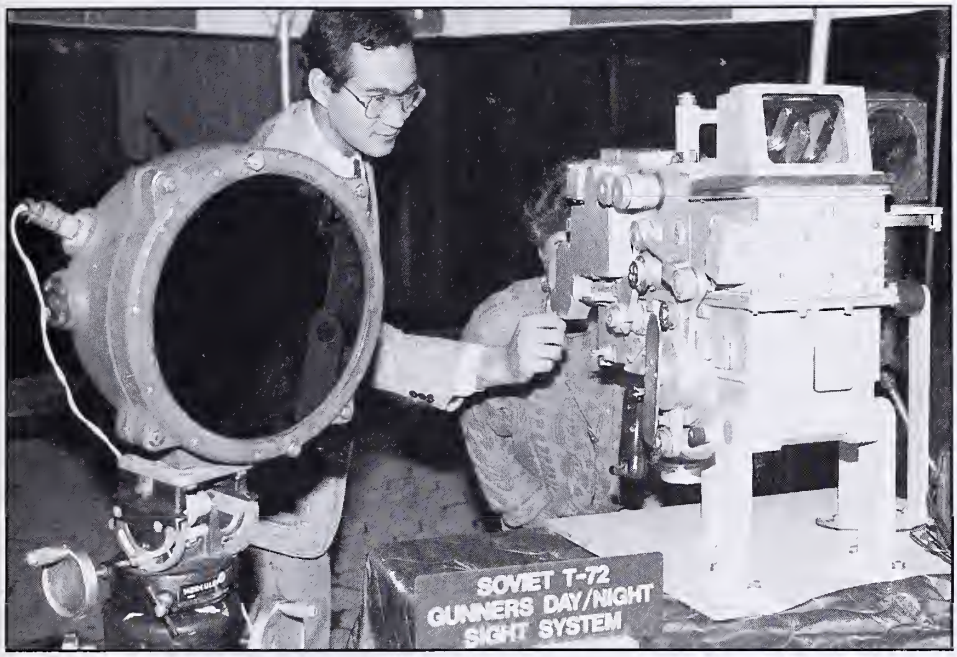
This advantage was restated by the U.S. Army Communications-Electronics Command's Night Vision and Electro-Optics Directorate at Fort Belvoir, VA, recently during a six-day demonstration of currently fielded equipment and future technology trends. More than 500 visitors from all services and numerous government agencies attended. Interest was high in light of the recent success in Southwest Asia.

Exhibits depicted ground (vehicle and manportable), airborne, and special applications of night vision equipment as well as advanced technology. However, the most exciting exhibits were the side-by-side comparisons of captured and other foreign equipment with currently fielded U.S. systems. They proved that the U.S., indeed, owned the night.

Weapon sights and goggles for the individual Iraqi soldier (first generation systems) were compared with systems used by U.S. ground forces (second and third generation goggles). U.S. equipment clearly showed much higher sensitivity and resolution. Visitors observed this superior technological advantage by using night vision goggles and traveling down a dark road in an open bed truck. Without the goggles,



Soviet T72 and BMP Commander's Sight.



Soviet T72 Gunners Day/Night Sight System shown with and IR spotlight which is necessary for its operation.

one could only see darkness all around. Decoys placed in the woods alongside the road were easily seen through the goggles. The scene through the goggle is 2,000 times brighter than that seen by the unaided eye. When pointed out by the infrared aiming light (which can only be seen through the goggles) they made easy targets. The aiming light, when boresighted to the weapon, allows accurate "fire from the hip" for the soldier.

Side-by-side demonstrations of Soviet-made and U.S. combat vehicular acquisition and fire control systems were also shown. Differences in U.S. and foreign equipment performance were dramatic. These differences are attributed mainly to the fact that none of the Iraqi equipment was thermal. An example of this was the captured Soviet T72 Gunner's Primary Sight—a Day Sight with a 1.06 micron laser rangefinder which is an active infrared (S1) sight (mechanically coupled to a day sight for elevation coverage) which must be used in conjunction with an active infrared searchlight. Although these devices were captured during Operation Desert Storm, they are not believed to represent current Soviet state-of-the-art in combat vehicle acquisition and fire control. In contrast, U.S. troops used first generation common module systems such as the Gunner's Primary Sight (Thermal Imaging Subsystem) and the Apache helicopter's Target Acquisition and Designation System (TADS). Both proved far superior to the enemy's, especially when challenged by conditions such as smoke from oil fires and blowing sand and dust.

Not limited to past successes, the NVEOD provided a glimpse into future development of electro-optical sensors which will maintain the lead for the U.S. The first prototype second generation Forward Looking Infrared (FLIR) devices with advanced image enhancements and target acquisition capabilities were demonstrated. A Blackhawk test bed helicopter was outfitted with a second generation FLIR device and the improved videotaped imagery was vividly demonstrated at tactical ranges.

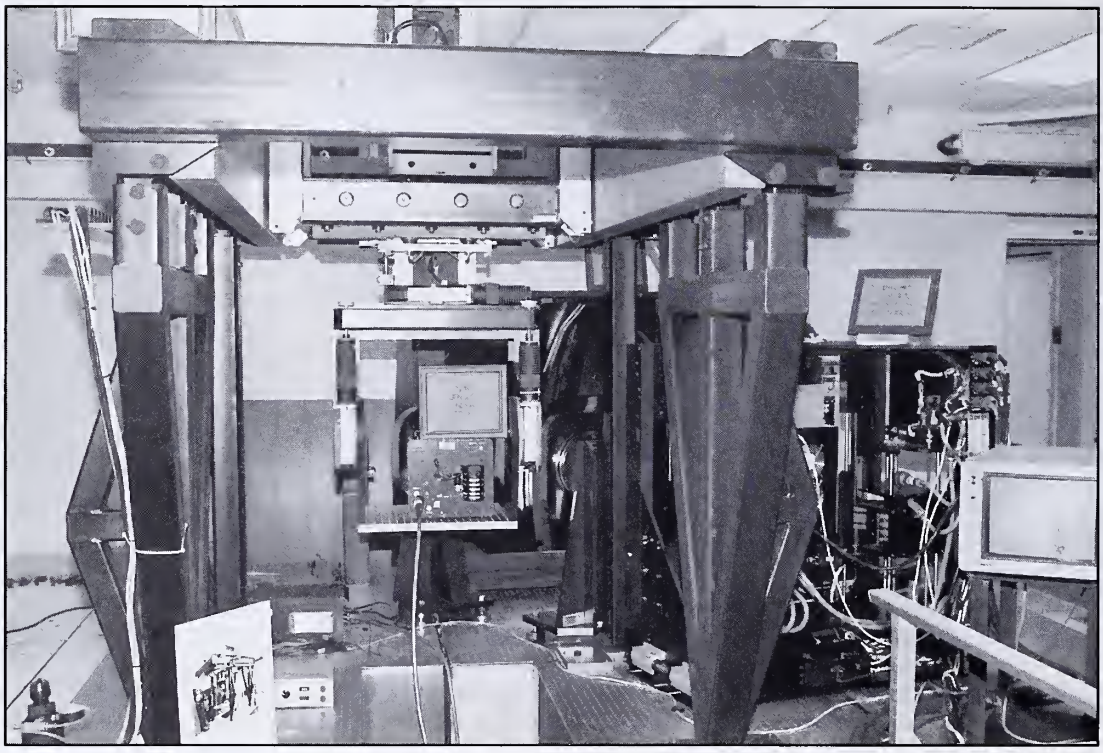
This FLIR, the Electro-Optical Sighting System (EOSS), is being developed for Comanche to meet increasing demands on the battlefield. Future efforts will couple the LONGBOW MMW radar and advanced aided target recognition with the second generation

Displayed Infantry Equipment

The individual weapon sight used by Iraq is a first generation system manufactured in the Netherlands. The U.S. weapon sight is a second generation device used on both individual and crew served weapons. Not evident at the recent demonstration was the first generation's problems of streaking and white-out due to tracers, muzzle flash, flares and other bright illumination sources.

The night observation device used by Iraq is a first generation type system given to NVEOD by the 5th Special Operations Forces. This system was manufactured in the Netherlands and is compared to a Far Infrared system used by U.S. forces. The performance difference here is quite dramatic—the U.S. system has at least twice the effective detection range of the Iraqi device.

The Night Vision Goggle (PGMS1) used by Iraq is a single stage first generation device whose overall gain is less than 60. Like the night observation device, it too was given to the NVEOD by the 5th SOF and manufactured in the Netherlands. An identical goggle was obtained by FSTC prior to Operation Desert Storm and evaluated by the NVEOD. Tests indicated that this goggle was useless below full moon illumination and required auxiliary illumination from vehicle IR lights. The U.S. night vision goggle (AN/PVS-7) is a third generation device (system gain 2,000) which functions in the passive mode well down into overcast starlight.



FLIR/Sensor Image Evaluation Facility

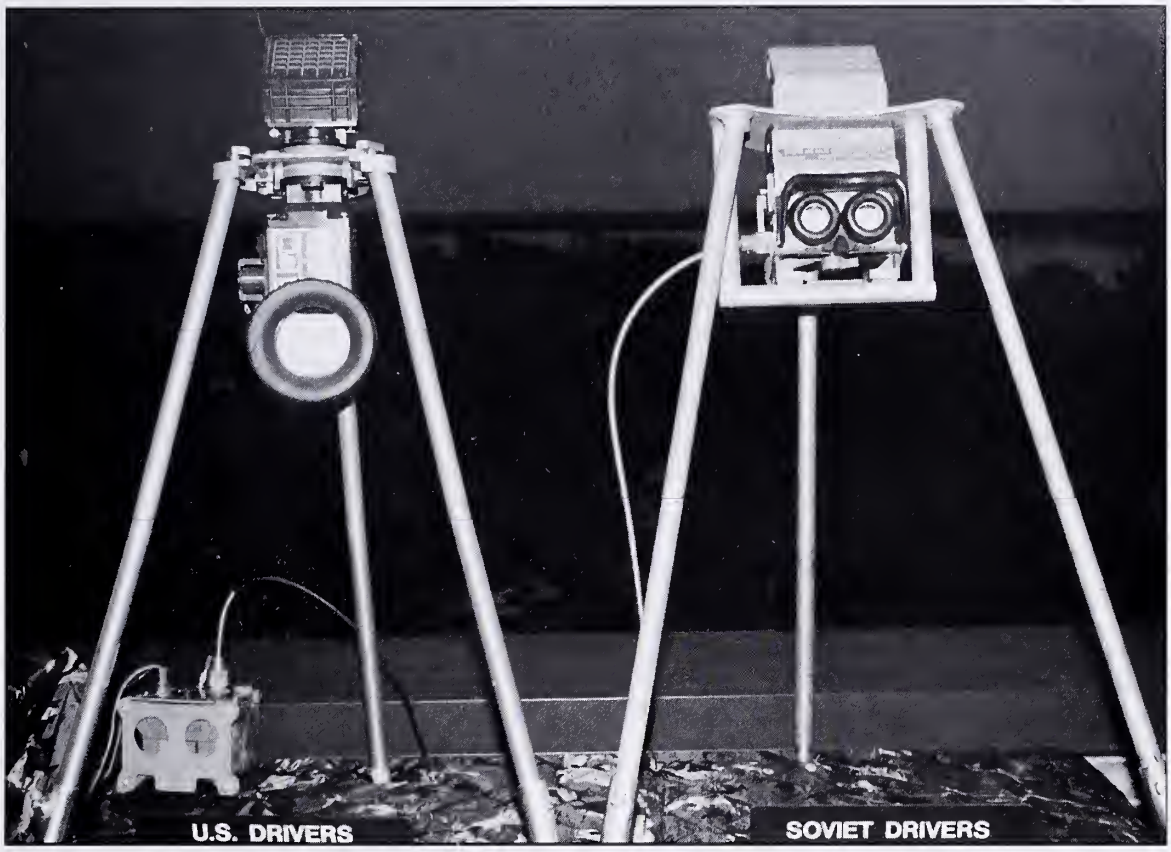
Displayed Armor Equipment

- U.S. Gunner's Primary Sight—Gunner's Primary Sight for the M1A1 Tank; includes the Thermal Imaging Subsystem (8 X day sight and unity sight).
- Soviet T72 Gunner's Primary Sight (captured)—Day sight with 1.06 micron laser rangefinder and control handles; active infrared (S1) sight attached (on left) mechanically coupled to day sight for elevation coverage; azimuth covered by traversing turret.
- Soviet T72 Gunner's Active IR Searchlight—Performance peaked to match S1 response; for driving and target acquisition.
- U.S. Army Combat Vehicle Driver's Viewer AN/VVS-2—Second generation image intensification.
- Soviet Driving Periscope—Left eye - active IR (S1); Right eye - passive IR (S20).
- U.S. Army Bradley Fighting Vehicle Sight (ISU)—Day/Night (passive) sight; no rangefinder.
- Soviet BMP Gunner's Sight—Active IR (S1) or passive IR (S20) day sight.
- Soviet T72 and BMP Commander's Sight—Active IR;

FLIR in a multisensor fusion effort to serve not only the Comanche, but also the Apache and future combat vehicles.

Additional exhibits at the airborne station included advanced pilotage programs such as the Obstacle Avoidance System (OASYS) which is designed to provide obstacle detection and warning. The pilot will be alerted to obstacles such as wires, towers and terrain along the flight path to allow for safe avoidance maneuvers. The Advanced Pilot's Aid, providing substantially improved field of view and resolution, was shown. It is the next generation, head-mounted image intensifier system which will help overcome limitation of presently fielded systems.

After completing the airborne exhibits, passengers were transported to the next exhibit via a small bus utilizing the Driver's Thermal Viewer (DTV). Video output to monitors afforded passengers the same imagery as the driver. The DTV employs FLIR technology which provides the capability to drive and detect targets during all light levels and through deliberate or naturally



Shown at left is the U.S. Army Combat Vehicle Driver's Viewer AN/VVS-2. At the right is the Soviet Driving Periscope.

occurring obscurants. This device was successfully used in Operation Desert Storm by Scout elements of the 24th Infantry Division. It is designed as a replacement for the image intensifier sight for night and obscurant driving on the Bradley and Abrams.

The Thermal Weapon Sight, Platinum Silicide staring technology prototypes and the uncooled thermal imaging prototype demonstrated tremendous improvements in smaller, lower-cost and lighter-weight thermal imaging systems for the individual soldier and special applications.

From the fourth floor terrace of the NVEOD building, FLIRs were fixed on thermal decoys and a High Mobility Multipurpose Wheeled Vehicle (HMMWV) located approximately two kilometers across Pohick Bay. The FLIR used was a manportable thermal imager (AN/TAS-6) with a "Scout Optics" kit attached. The Scout Optics kit, developed for use by Forward Scouts in Southwest Asia, is a two-power lens attachment which extends the FLIR's range by a factor of two. These kits are presently being fielded in the European theatre. A MELIOS (Mini-Eyesafe Laser Infrared Observation Set) was boresighted with the FLIR and used to activate a thermal beacon mounted on the HMMWV. When activated by the correct frequency, a distinct, flashing black/white signal was emitted indicating that the vehicle is friendly.

The thermal beacon is being tested as a near-term solution for combat identification. The beacon's source of thermal radiation consists of an electrically heated film on the hot side and a sky reflector mirroring the cold sky background on the cold side. Use of both hot and cold ensures the signal can be detected under all background conditions in which the target can be detected. The beacon can be activated either manually or automatically for a preset period by means of an interrogating laser pulse. Laser radiation is detected by a laser receiver collocated with the beacon. Initial field testing of the thermal beacon has shown reliable vehicle identification at significant ranges using the Tank Thermal Sight and the Apache's TADS FLIR.

Tours of the research facilities and the ongoing efforts included key technology areas of infrared detection, diode array pumped solid state lasers, laser protection, aided target recognition algorithm development, and sensor and processor evaluation technology evolution. The FLIR/Sensor Image Evaluation Facility tests up to 150 domestic and foreign systems each year and is considered to be the "National Bureau of Standards" in thermal sensor evaluation.

General Schwarzkopf wrote, "The young American servicemen and women deserve nothing but the best equipment possible. In the case of night vision technology, you certainly provided that equipment." The CECOM Night Vision and Electro-Optics Directorate continues to work toward maintaining the technological edge for the soldier.

MARTHA MCCASLIN is a program integration specialist with the Night Vision and Electro-Optics Directorate at Fort Belvoir, VA.

Army Holds Second Acquisition Career Management Conference

Issues concerning Army Acquisition Corps (AAC) career management were discussed at the second AAC Career Management Conference Nov. 5-6, 1991, at Fort Belvoir, VA. More than 60 of the Army's senior leadership from the acquisition community met to discuss continuing topics associated with career management, such as: training, educating and professionalizing the workforce, identifying and structuring the workforce, and managing the workforce.

LTG August M. Cianciolo, director of Army acquisition career management and sponsor of the conference, welcomed the attendees. Cianciolo stated that the objectives of the conference were: to involve senior leadership in policy formulation that will guide overall structure, training, development, management, education and selection; to review and assess progress; and to chart a course for future actions.

Colleen Preston, general counsel for the House Committee on Armed Services, gave the keynote address on the DOD Acquisition Workforce Improvement Act.

Other conference speakers included: COL Al Greenhouse, deputy director of Army acquisition career management; Dr. James D. McMichael, director of acquisition education, training and career policy, Office of the Under Secretary of Defense (Acquisition); Dr. James H. Edgar, assistant deputy director of Army acquisition career management; Miriam F. Browning, vice-director for information management, Office of the Director of Information Systems for Command, Control, Communications and Computers; Darold L. Griffin, principal assistant deputy for research, development and acquisition, Headquarters, U.S. Army Materiel Command; BG Otto J. Guenther, program executive officer (PEO) for Communications Systems; and the Hon. Stephen K. Conver, assistant secretary of the Army (Research, Development and Acquisition).

In addition, program executive officers presented briefings on civilian greening. Each PEO outlined what his organization is doing to improve civilian understanding of the environment where soldiers and commanders use the equipment that they develop, procure and field. Also, the PEOs identified the units with which they are establishing partnerships for this endeavor.

Four work groups were established to identify action items and initiatives related to management oversight, training and education, the requirements process, and responsibility, authority and accountability. These groups met simultaneously to devise implementation plans for resolving specific issues.

In the final session of the conference, work group reports were presented by each group leader. These reports highlighted and recommended solutions to the issues discussed.

In his luncheon remarks, Hon. Stephen K. Conver emphasized the importance of attracting, selecting and retaining the best possible acquisition professionals for the overall goal of acquiring equipment on behalf of the American soldier.

According to Conver, "The goal of Army modernization should be to put world-class equipment into the hands of the soldier in sufficient quantity in the shortest possible time consistent with sound business practices and affordability constraints."

"When you hear somebody in the Army talk about how we should have a trained and ready Army, you might remind them that what we really need is a trained and ready, well-equipped Army," Conver said.

"If we're to attract and retain the best and the brightest, we have to provide meaningful careers that involve significant potential for promotion to the highest levels," Conver added.

Also, Conver discussed other issues concerning AAC career management, such as the waivers, treating military and civilian members alike to the greatest extent possible, branch identity, training and education, and mobility requirements. In the conference wrap-up, LTG Cianciolo reviewed recommended actions and assignments for completing them. All conference issues will be assessed and feedback provided to conferees at a follow-on conference tentatively scheduled for May 1992.

Defense Acquisition Workforce Improvement Act (P.L. 101-510)

This is the third installment of extracts from the new legislation:

"Subchapter III—Acquisition Corps Section 1734. CAREER DEVELOPMENT

(a) THREE-YEAR ASSIGNMENT PERIOD.—(1) Except as provided under subsection (b), the Secretary of each military department, acting through the service acquisition executive for that department, shall provide that, on and after October 1, 1993, any person who is assigned to a critical acquisition position shall be assigned to the position for not fewer than three years. Except as provided in subsection (d), the Secretary concerned may not reassign a person from such an assignment before the end of the three-year period.

(2) A person may not be assigned to a critical acquisition position unless the person executes a written agreement to remain on active duty (in the case of a member of the armed forces) or to remain in Federal service (in the case of an employee) in that position for at least three years. The service obligation contained in such a written agreement shall remain in effect unless and until waived by the Secretary concerned under subsection (b).

(b) ASSIGNMENT PERIOD FOR PROGRAM MANAGERS.—(1) The Secretary of Defense shall prescribe in regulations—

(A) a requirement that, on and after October 1, 1991, a program manager and a deputy program manager of a major defense acquisition program be assigned to the position at least until completion of the major milestone that occurs closest in time to the date on which the person has served in the position for four years; and

(B) a requirement that, on and after October 1, 1991, to the maximum extent practicable, a program manager who is the replacement for a reassigned program manager, arrive at the assignment location before the reassigned program manager leaves. Except as provided in subsection (d), the Secretary concerned may not reassign a program manager or deputy program manager from such an assignment until after such major milestone has occurred.

(2) A person may not be assigned to a critical acquisition position as a program manager or deputy program manager of a major defense acquisition program unless the person executes a written agreement to remain on active duty (in the case of a member of the armed forces) or to remain in Federal service (in the case of an employee) in that position at least until completion of the first major milestone that occurs closest in time to the date on which the person has served in the position for four years. The service obligation contained in such a written agreement shall remain in effect unless and until waived by the Secretary concerned under subsection (d).

(c) MAJOR MILESTONE REGULATIONS.—(1) The Secretary of

Defense shall issue regulations defining what constitutes major milestones for purposes of this section. The service acquisition executive of each military department shall establish major milestones at the beginning of a major defense acquisition program consistent with such regulations and shall use such milestones to determine the assignment period for program managers and deputy program managers under subsection (b).

(2) The regulations shall require that major milestones be clearly definable and measurable events that mark the completion of a significant phase in a major defense acquisition program and that such milestones be the same as the milestones contained in the baseline description established for the program pursuant to section 2435(a) of this title. The Secretary shall require that the major milestones as defined in the regulations be included in the Selected Acquisition Report required for such program under section 2432 of this title.

(d) WAIVER OF ASSIGNMENT PERIOD.—(1) With respect to a person assigned to a critical acquisition position, the Secretary concerned may waive the prohibition on reassignment of that person (in subsection (a)(1) or (b)(1) and the service obligation in an agreement executed by that person (under subsection (a)(2) or (b)(2)), but only in exceptional circumstances in which a waiver is necessary for reasons permitted in regulations prescribed by the Secretary of Defense.

(2) The authority to grant such waivers may be delegated by the service acquisition executive of a military department only to the Director of Acquisition Career Management for the military department.

(3) With respect to each waiver granted under this subsection, the service acquisition executive (or his delegate) shall set forth in a written document of the rationale for the decision to grant the waiver. The document shall be submitted to the Director of Acquisition Education, Training, and Career Development.

(e) ROTATION POLICY.—(1) The Secretary of Defense shall establish a policy encouraging the rotation of members of an Acquisition Corps serving in critical acquisition positions to new assignments after completion of five years of service in such positions, or, in the case of a program manager, after completion of a major program milestone, whichever is longer. Such rotation policy shall be designed to ensure opportunities for career broadening assignments and an infusion of new ideas into critical acquisition positions.

(2) The Secretary of Defense shall establish a procedure under which the assignment of each person assigned to a critical acquisition position shall be reviewed on a case-by-case basis, by the acquisition career program board of the department concerned, for the purpose of determining whether the Government and such person would be better served by a reassignment to a different position. Such a review shall be carried out with respect to each such person not later than five years after that person is assigned to a critical position.

(f) CENTRALIZED JOB REFERRAL SYSTEM.—The Secretary of Defense shall prescribe regulations providing for the use of centralized lists to ensure that persons are selected for critical positions without regard to geographic location of applicants for such positions.

(g) EXCHANGE PROGRAM.—(1) The Secretary of Defense shall establish, for purposes of broadening the experience of members of each Acquisition Corps, a test program in which members of a Corps serving in a military department or Defense Agency are assigned or detailed to an acquisition position in another department or agency. Under the test program, the Secretary of Defense shall ensure that, to the maximum extent practicable, at least 5 percent of the members of the Acquisition Corps shall serve in such exchange assignments each year. The test program shall operate for not less than a period of three years.

(2) The Secretary of Defense shall submit the portion of the test program applicable to civilian employees to the Director of the Office of Personnel Management for approval. If the Director does not disapprove that portion of the test program within 30 days after the date on which the Director receives it, that portion of the test program is deemed to be approved by the Director.

(h) RESPONSIBILITY FOR ASSIGNMENTS.—The Secretary of each military department, acting through the service acquisition executive for that department, is responsible for making assignments of civilian and military members of the Acquisition Corps of that military department to critical acquisition positions.

Section 1735. EDUCATION, TRAINING, AND EXPERIENCE REQUIREMENTS FOR CRITICAL ACQUISITION POSITIONS

(a) QUALIFICATION REQUIREMENTS.—In establishing the education, training, and experience requirements under section 1723 of this title for critical acquisition positions, the Secretary of Defense shall, at a minimum, include the requirements set forth in subsections (b) through (e).

(b) PROGRAM MANAGERS AND DEPUTY PROGRAM MANAGERS.—Before being assigned to a position as a program manager or deputy program manager of a major defense acquisition program or a significant nonmajor defense acquisition program, a person—

(1) must have completed the program management course at the Defense Systems Management College or a management program at an accredited educational institution determined to be comparable by the Secretary of Defense;

(2) must have executed a written agreement as required in section 1734(b)(2); and

(3) in the case of—

(A) a program manager or deputy program manager of a major defense acquisition program, must have at least eight years of experience in acquisition, at least two years of which were performed in a systems program office or similar organization; and

(B) a program manager or deputy program manager of a significant nonmajor defense acquisition program, must have at least six years of experience in acquisition.

(c) PROGRAM EXECUTIVE OFFICERS.—Before being assigned to a position as a program executive officer, a person—

(1) must have completed the program management course at the Defense Systems Management College or a management program at an accredited educational institution in the private sector determined to be comparable by the Secretary of Defense, acting through the Under Secretary of Defense for Acquisition;

(2) must have at least 10 years experience in an acquisition position, at least four years of which were performed while assigned to a critical acquisition position; and

(3) must have held a position as a program manager or a deputy program manager.

(d) GENERAL AND FLAG OFFICERS AND CIVILIANS IN EQUIVALENT POSITIONS.—Before a general or flag officer, or a civilian serving in a position equivalent in grade of such an officer, may be assigned to a critical acquisition position, the person must have at least 10 years experience in an acquisition position, at least four years of which were performed while assigned to a critical acquisition position.

(e) SENIOR CONTRACTING OFFICIALS.—Before a person may be assigned to a critical acquisition position as a senior contracting official, the person must have at least four years experience in con-

tracting.

Section 1736. APPLICABILITY

(a) IN GENERAL.—Except as provided in subsections (b) and (c), the qualification requirements prescribed pursuant to section 1735 shall apply to all critical acquisition positions not later than October 1, 1992.

(b) PROGRAM MANAGERS.—The qualification requirements prescribed pursuant to section 1735 shall apply with respect to program manager positions not later than October 1, 1991.

(c) EXCEPTIONS.—The qualification requirements prescribed pursuant to sections 1733(a) and 1735(a) shall not apply—

(1) to an employee who is serving in a critical acquisition position on October 1, 1992, for purposes of qualifying to continue to serve in such position; or

(2) to a person who is serving in a program manager position on October 1, 1991, for purposes of qualifying to continue to serve in such position.

Section 1737. DEFINITIONS AND GENERAL PROVISIONS

(a) DEFINITIONS.—In this subchapter:

(1) The term 'program manager' means, with respect to a defense acquisition program, the member of an Acquisition Corps responsible for managing the program, regardless of the title given the member.

(2) The term 'deputy program manager' means the person who has authority to act on behalf of the program manager in the absence of the program manager.

(3) The term 'significant nonmajor defense acquisition program' means a Department of Defense acquisition program that is not a major defense acquisition program (as defined in section 2430 of this title) and that is estimated by the Secretary of Defense to require an eventual total expenditure for research, development, test, and evaluation of more than $50,000,000 (based on fiscal year 1980 constant dollars) or an eventual total expenditure for procurement of more than $250,000,000 (based on fiscal year 1980 constant dollars).

(4) The term 'program executive officer' has the meaning given such term in regulations prescribed by the Secretary of Defense.

(5) The term 'senior contracting official' means a director of contracting, or a principal deputy to a director of contracting, serving in the office of the Secretary of a military department, the headquarters of a military department, the head of a Defense Agency, a subordinate command headquarters, or in a major systems or logistics contracting activity in the Department of Defense.

(b) LIMITATION.—Any civilian or military member of the Corps who does not meet the education, training, and experience requirements for a critical acquisition position established under this subchapter may not carry out the duties or exercise the authorities of that position, except for a period not to exceed six months, unless a waiver of the requirements is granted under subsection (c).

(c) WAIVER.—(1) The Secretary of each military department (acting through the service acquisition executive for that department) or the Secretary of Defense (acting through the Under Secretary of Defense for Acquisition) for Defense Agencies and other components of the Department of Defense may waive, on a case-by-case basis, the requirements established under this subchapter with respect to the assignment of an individual to a particular critical acquisition position. Such a waiver may be granted only if unusual circumstances justify the waiver or if the Secretary concerned (or official to whom the waiver authority is delegated) determines that the individual's qualifications obviate the need for meeting the education, training, and experience requirements established under this subchapter.

(2) The authority to grant such waivers may be delegated—

(A) in the case of the service acquisition executives of the military departments, only to the Director of Acquisition Career Management for the military department concerned; and

(B) in the case of the Under Secretary of Defense for Acquisition, only to the Director of Acquisition, Education, Training, and Career Development.

(d) OPM APPROVAL.—The Secretary of Defense shall submit any requirement with respect to civilian employees established under this subchapter to the Director of the Office of Personnel Management for approval. If the Director does not disapprove the requirement within 30 days after the date on which the Director receives the requirement, the requirement is deemed to be approved by the Director."

MOU Establishes Unit Affiliation Program

New ground was broken on Oct. 1, 1991, when MG John H. Tilelli Jr., commanding general of the First Cavalry Division, and Dale G. Adams, program executive officer (PEO) for armaments signed a memorandum of understanding (MOU) establishing a Unit Affiliation Program between their organizations. The MOU paves the way for strengthening relations between the operational and materiel acquisition communities.

The birth of this initiative was at the Army Acquisition Corps (AAC) Career Management Conference held March 25-26, 1991. The senior managers realized that the number of military personnel in the acquisition business with extensive operational experience will gradually diminish. After their initial years in the Army, AAC military personnel will be trained and will specialize in the technical and business aspects of acquisition. Of concern was the fact that because the Army is all volunteer, AAC civilians will likely have minimal, if any, experience with the operational aspects of weapon systems and their employment. Responding to these issues, the participating PEOs and acquisition management officials recommended an effort to "explore a regimental affiliation program" as a means of providing "greening" experiences for the civilian work force and regreening opportunities for military AAC members. In essence, AAC personnel would be exposed to the realities of a soldier's life in order to ensure that people who are designing and purchasing Army hardware and software understand soldier needs.

At the Armor Conference at Fort Knox in May, 1991, MG Tilelli indicated that his division would be interested in such a program. Immediately, a proposed program outline was drafted and floated to the Cavalry. The approach was to provide the chance for temporary duty assignments with the First Cavalry Division to personnel from the Program Executive Office, its PM offices, and their matrix support elements. Participants would be able to observe unit operations during field training exercises, interact with the troops and acquire first hand insight into a soldier's environment. Similarly, First Cavalry Division personnel would be afforded the opportunity to learn more about materiel acquisition and development via visits to the Program Executive Office for Armaments, its PM offices and the government/contractor facilities that support their programs. In this sense, the program would be a two-way street.

On Oct. 1, the PEO and his project managers were welcomed at the First Cavalry Division Headquarters at Fort Hood, TX. MG Tilelli and his staff explained the division's operations and its needs after

which the PEO group went directly to the motor pool of the 1/32 Armor's "Bandits" to receive hands-on orientations on the combat equipment.

The distinguished lineage and achievements of the "First Team" were impressed upon the PEO group as they visited the First Cavalry Museum. The museum's large display of captured Iraqi vehicles and weapons testified to the division's superb performance in Desert Storm.

A luncheon followed with the commanding general, his assistant, BG John Abrams, the division's chief of staff, COL George Casey, and the full complement of First Team's brigade commanders. This was an excellent opportunity for the PEO's materiel developers to obtain more feedback on how the division's current equipment performs, ways to improve it, and needs for the future.

Late last year, John Corsello, an engineer and tank weapons system specialist from the PEOs and Program Management Directorate, became the first PEO Armaments Volunteer to serve on temporary duty with the division. Other enthusiastic volunteers—all looking forward to the experience with real soldiers—will follow.

69 Graduate from MAM

On Sept. 27, 1991, 69 students graduated from the Materiel Acquisition Management Course held at the U.S. Army Logistics Management College, Fort Lee, VA. Research and development, testing, contracting, requirements generation, acquisition, logistics and production management are examples of the acquisition work assignments of these graduates.

Dale G. Adams, program executive officer for armaments, Picatinny Arsenal, NJ, gave the graduation address and presented the diplomas. The Distinguished Graduate Award was presented to MAJ Valerie Rasmussen, U.S. Army Information Systems Selection Acquisition Agency, Alexandria, VA, and the Outstanding Graduate Award was presented to CPT Michael White, U.S. Army Quartermaster Center and School, Fort Lee, VA.

The nine-week Materiel Acquisition Management Course provides a broad knowledge of the materiel acquisition function. Course coverage includes national policies and objectives that shape the acquisition process and the implementation of these policies and objectives by the U.S. Army. Students are exposed to acquisition concepts and policies; research, development, test, and evaluation; financial and cost management; integrated logistics support; force modernization; production management; and contract management. Emphasis is placed on developing mid-level managers so that they can effectively participate in the management of the acquisition process.

AAC Proponency Office Relocates

The AAC Proponency Office recently relocated to the Pentagon. The new phone numbers are DSN 224-4288/225-8454 or (703) 614-4288/695-8454. The mailing address is HQDA, ATTN: SARD-AC, Washington, DC 20310.

AAC Command Position List

The Chief of Staff, Army granted approval to allow AAC FA 51 and FA 97 officers to assume functional area TDA commands when those positions are determined to be acquisition related and added to the AAC critical position list. The following is a listing of Acquisition Corps commands:

Command	Grade	FA
U.S. Army Atmospheric Test Laboratory	COL	51
U.S. Army Vulnerability Assessment Team	COL	51
U.S. Army Jefferson Proving Ground	COL	51
U.S. Army Combat Systems Test Activity	COL	51
U.S. Army Yuma Proving Ground	COL	51
U.S. Army Close Combat Armaments Center	COL	51
U.S. Army Fire Support Armaments Center	COL	51
U.S. Army Aviation Logistics Center	COL	51
U.S. Army Aviation Technical Test Center	COL	51
DCMAO Baltimore	COL	97
DCMAO Birmingham	COL	97
DCMAO Chicago	COL	97
DCMAO Cleveland	COL	97
DCMAO Detroit	COL	97
DCMAO Europe	COL	97
DCMAO Garden City	COL	97
DCMAO Indianapolis	COL	97
DCMAO New York	COL	97
DCMAO Ottawa	COL	97
DCMAO Phoenix	COL	97
DCMAO St Louis	COL	97
DCMAO Springfield	COL	97
DCMAO Syracuse	COL	97
DCMAO Van Nuys	COL	97
DPRO Bell Helicopter	COL	97
DPRO Boeing Helicopter	COL	97
DPRO LTV Aerospace and Defense	COL	97
DPRO McDonnell Douglas	COL	97
DPRO Raytheon	COL	97
DCMAO Dallas	COL	97
European Contracting Command	COL	97
Korean Contracting Agency	COL	97
DCMAO Cedar Rapids	LTC	97
DCMAO Clearwater	LTC	97
DCMAO Grand Rapids	LTC	97
DCMAO Milwaukee	LTC	97
DCMAO Reading	LTC	97
DCMAO Seattle	LTC	97
DCMAO Tel Aviv	LTC	97
DPRO BMY	LTC	97
DPRO FMC	LTC	97
DPRO Ford Aerospace	LTC	97
DPRO GTE	LTC	97
DPRO Harris	LTC	97
DPRO Honeywell	LTC	97
DPRO Kaman Aerospace	LTC	97
DPRO Link Flight Simulators	LTC	97
DPRO McDonnell Douglas	LTC	97
DPRO Textron-Lycoming	LTC	97
DPRO General Dynamics (Warren)	LTC	97
DPRO General Dynamics (Lima)	LTC	97
DPRO Martin Marietta	LTC	97

CONFERENCES

MICOM/Air Force Sponsor Concurrent Engineering Symposium

The U.S. Army Missile Command (MICOM) and the U.S. Air Force will sponsor a Concurrent Engineering Symposium in Fort Walton Beach, FL, on March 31, 1992, titled "C.E. Applications." The agenda will include presentations and case studies by representatives of industry, government, and academia.

For more information contact Julie Logan at the University of Alabama in Huntsville, commercial (205)895-6343 or John Montgomery at MICOM, DSN 788-4247 or commercial (205)895-4247.

18th Army Science Conference Scheduled

Seventy-five technical papers focusing on key emerging technologies, including systemic issues and supporting capabilities, will be presented at the 18th Army Science Conference, June 22-25, 1992 in Orlando, FL. More that 800 representatives from the Army, industry and academia are expected to attend.

Initiated in 1957, the conference is designed to provide a forum for presentation, discussion and recognition of significant accomplishments by Army scientists and engineers. In addition to technical paper presentations, the conference will feature exhibits demonstrating the latest technologies in government labs and research, development and engineering centers.

For additional conference information call (513) 426-8530.

Smoke/Obscurants Symposium Scheduled

Smoke/Obscurants Symposium XVI will be held April 14-16, 1992 at the Kossiakoff Conference and Education Center, The Johns Hopkins University, Laurel, MD. The theme of the symposium is "Smoke, the Margin of Victory." Topics to be presented are Smoke Systems and Materiels, Modelling, Operational Uses, Health or Environmental Effects, Desert Storm Lessons, Countermeasures, Nonmilitary Applications, Data Analysis, Data Assessment and Evaluation, Camouflage, Concealment, Deception, Natural Obscurants, and Electromagnetic Systems Performance. The symposium is sponsored by the U.S. Army Chemical Research, Development and Engineering Center, Aberdeen Proving Ground, MD. For more information contact Judy Cole, symposium coordinator (804) 865-7604 or telefax (804)865-8721; or Walter Klimek, symposium chairman (301) 671-2494, DSN 584-2494 or telefax (301) 671-3471.

PEO/PM Conference Scheduled

A PEO/PM Conference is scheduled to be held at the Sheraton Orlando North Hotel in Orlando, FL, Jan. 15-17, 1992. For further information, contact Barbara Hoskins at (703)693-7323 or DSN 223-7323. In addition, a pre-conference meeting will be held Jan. 14-15, 1992, for PEOs/PMs who wish to attend briefings designed to provide current and relative information in support of the PEO/PM conference. For more information concerning the pre-conference meeting, contact COL John Bramblett or Dale Fradley at (703)274-9570/9710 or DSN 284-9570/9710.

35th International Power Sources Symposium

The 35th International Power Sources Symposium will be held June 22-25, 1992, in Cherry Hill, NJ. The symposium will be sponsored by The Institute of Electrical and Electronics Engineers, Inc. Industry Applications Society with the participation of the U.S. Army Electronics Technology and Devices Laboratory (ETDL) and ETDL's Power Sources Division, and other Army, Navy, Air Force, Department of Energy and DOD agencies.

Fourteen unclassified technical sessions will address topics such as the research, development, engineering and applications of batteries and energy conversion devices and related technologies. Session titles are: Superconductivity for Power Applications and Energy Storage; Sodium Sulfur/Applications; Primary Lithium I; Primary Lithium II; Aqueous Rechargeable; Lithium Rechargeable Batteries I; Low Rate Rechargeable Lithium Batteries II; Low Rate Rechargeable Lithium Batteries III; Commercial/Primary Lithium/Alkaline; High Temperature Batteries; Thermal/Reserve Batteries; Electrostatic Energy Storage; Pulse Power Batteries/Electrochemical Capacitors; and Fuel Cells/Air Batteries.

For additional information, contact U.S. Army Electronics Technology and Devices Laboratory, LABCOM, ATTN: SLCET-P, Fort Monmouth, NJ 07703-5601, Commercial (908)532-0003 or Autovon 992-0003.

Helicopter Cable Warning Systems Evaluated

The Aviation Applied Technology Directorate (AATD), Fort Eustis, VA, has awarded an eight-month $400,000 contract to PROAV International Aviation Services Corporation, Ottawa, Canada, to provide helicopter cable warning systems (CWS) and technical support for a U.S. Army field evaluation in Germany and Korea. The CWS functions as an alerting device when exposed to the magnetic fields gener-

ated by the flow of electric current.

"Many of the Army's missions involve low-level flight that places our aviators at risk for wire strikes," explained Kent Smith, project engineer, AATD.

"This system has demonstrated from engineering testing at Fort Eustis that it may have the potential to provide pilots sufficient warning to avoid the majority of current-carrying wires. This upcoming evaluation should determine if the CWS is capable of providing the needed safety margins for saving lives overseas, where power grid systems operate at a 50 Hz frequency, as opposed to 60 Hz in this country," said Smith.

USAETL Becomes Topographic Engineering Center

Effective Oct. 1, 1991, the U.S. Army Engineer Topographic Laboratories (ETL) was renamed the U.S. Army Topographic Engineering Center. The change, announced by the U.S. Army Corps of Engineers, was made to better reflect the changing mission of ETL. The Topographic Engineering Center retains the same location and phone numbers as the ETL.

New Software Available

The Research Institute at the University of Alabama in Huntsville is offering two new software packages:

Best Practices—How to Avoid Surprises in the World's Most Complicated Technical Process, a manual developed by the Department of the Navy, serves as an aid to the engineer concerned with the design, test, and production of weapon systems. The manual covers such topics as: funding, design, test, production, transition planning, facilities, logistics and management. Under each main topic are subtopics which compare the benefits of best practices to the consequences of the currently used approach. This manual was originally a product of the Reliability, Maintainability, and Quality Assurance Directorate through the Office of the Assistant Secretary of the Navy.

Basic Training in TQM Analysis Techniques is a manual which describes appropriate analysis techniques, such as the Shewhart Cycle, Range and Control Charts, Ishikawa Charts and others. Total Quality Management (TQM) is a DOD initiative for continuously improving performance at every level, in every area of DOD responsibility, and its implementation requires the use of the appropriate analysis techniques listed above. *Basic Training in TQM Analysis Techniques,* authored by Anthony Coppolla of the Systems Reliability and Engineering Division at Griffis AFB, has been used extensively throughout DOD as a tool to increase the awareness and understanding of TQM. This guide emphasizes practical use of current techniques, and provides references for readers who are interested in mathematical derivations and proofs.

Conversion of these manuals to disk, and distribution of the softcopy versions, are projects of the PE Tools program, which is administered by the Production Engineering Division, U.S. Army Missile Command, Huntsville, AL. Both of the new software applications utilize Hypercard, a common application accompanying most MacIntosh computer systems. A maximum request of one copy of each software package may be obtained free of charge by submitting your request to: University of Alabama in Huntsville, Research Institute, RI E-47, ATTN: Julie Logan, Huntsville, AL 35899. For additional information, call (205)895-6343.

Thermal Jackets Give a Cold Shoulder to Desert Heat

If you have ever sweltered under a hot desert sun, probably the farthest thought from your mind was to put on a jacket. But that is exactly what some British soldiers did while participating in the Persian Gulf War, and what they learned from their experience may someday benefit U.S. Army troops if war should break out again in the Persian Gulf.

The Britishers used a special thermal jacket now under development that actually helped to keep them cool. At the U.S. Army Tank-Automotive Command (TACOM), Warren, MI, researchers who recently evaluated it said they were highly impressed with its performance.

The thermal jacket is a product of the British-based Colebran Company Ltd. It is made of a proprietary, canvas-like, heat-reflecting material that the firm is now developing for the British government. Each jacket is custom-made to fit snugly around selected exterior surface areas of a combat-vehicle hull, such as the crew and ammunition compartments. Once in place, it reflects the sun's radiation, thereby preventing it from passing through the walls of the hull and raising the vehicle's interior temperature to excessive levels.

The British tried the thermal jacket on their command and control vehicles operating in Southwest Asia and reported interior temperatures 40 to 50 degrees Fahrenheit cooler than they would have been without it.

"Lowering the temperature not only helps vehicle crews," explained TACOM engineer George Simon, who headed the jacket evaluations, "but also keeps the ammunition from getting too warm. We showed in our evaluation that it is possible to effectively lower interior temperatures by using the jackets."

TACOM's participation in the jacket project began last January, when its Research, Development and Engineering Center agreed to conduct laboratory evaluations of the concept in response to potential Desert Storm problems as a proactive measure to anticipated vehicle latent heat buildup. Engineers evaluated thermal jackets on an M1A1 tank, an M113-series armored personnel carrier and a Marine Corps LAV (Light Armored Vehicle).

The evaluations involved parking each vehicle in a laboratory test cell under an array of infrared lamps, which were used to simulate the average noonday Arabian desert sun. Then, with the room air temperature at about 120 F, technicians exposed the vehicles for eight hours with and without jacket protection and compared their exterior and interior temperatures.

Simon said that in all three vehicles, the thermal jackets kept the interior temperatures substantially cooler than when the vehicles were unprotected. In the M1A1 test, for instance, he said the crew- compartment temperature reached 115 F without protection, compared to only 81 F with a thermal jacket, and the ammunition-compartment temperatures were 140 F and 90 F, respectively. Despite their high degree of effectiveness, however, Simon said the thermal jackets are not likely to show up soon on Army vehicles. "The day that we finished up our evaluations at TACOM was the day Operation Storm was basically over," Simon said. "So we did not go through the emergency procedures of trying to buy them."

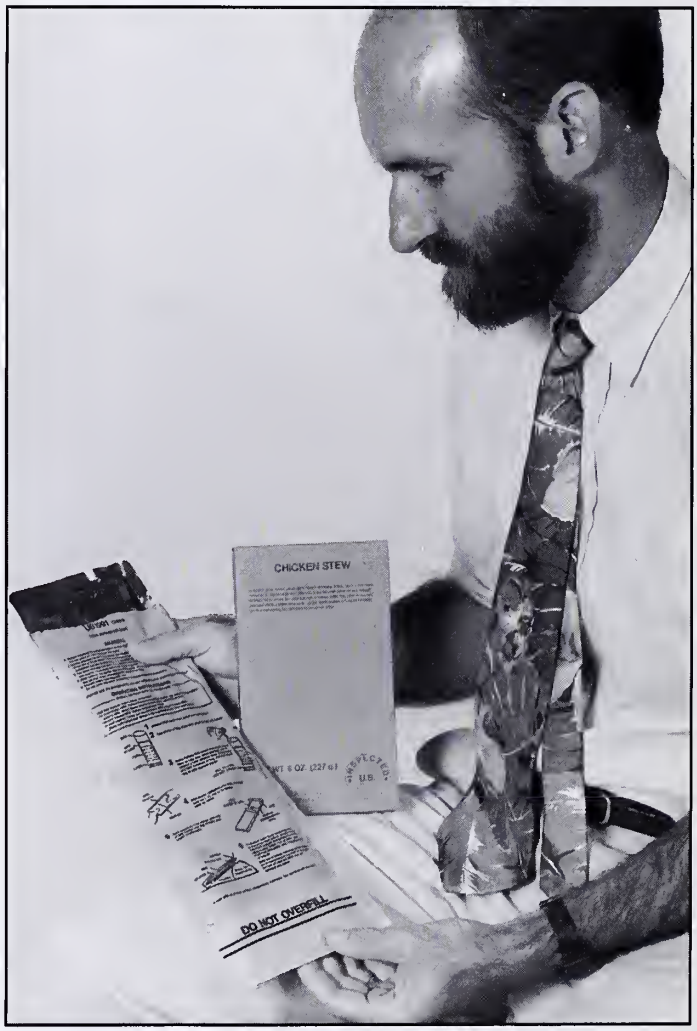
Natick Researchers Develop Insulator

The U.S. Army Natick Research, Development and Engineering Center's material developers, (left to right) Deidre Rapacz, Margaret Auerbach and Steve Fossey, display the Primaloft synthetic fiber-based polyester insulator developed as an alternative to waterfowl down. Primaloft is a superior high loft (loft is the height of the fibers in the batting), staple-bonded polyester batting which is extremely resistant to water absorption and has high insulation efficiency. The high percentage of very fine fibers, combined with the relatively small percentage of large diameter fibers, give Primaloft virtually the same warmth-to weight and compression recovery ratio as down. Primaloft represents a dramatic step forward in the search for an effective alternative to down as an insulator in outdoor clothing and sleeping bags.

Primaloft

Flameless Ration Heater

U.S. Army Natick Research, Development and Engineering Center mechanical engineer, Donald Pickard, displays the meal-ready-to-eat (MRE) Flameless Ration Heater (FRH) developed to provide soldiers in the field with a hot meal. The FRH consists of an active magnesium- iron and inert plastic powder pad weighing less than an ounce, packaged in a bag sized to hold an eight ounce MRE entree. After inserting the ration in the bag and pouring in an ounce of cold water, an electrochemical reaction is initiated that raises the temperature of the entree to 100 degrees Fahrenheit in about 12 minutes. The FRH is a flameless device that can be used safely in tents, shelters, vehicles, even in the Battle Dress Uniform pant pocket allowing convenient dining anytime, anyplace.



Flameless Ration Heater

TACOM Studies Electric Vehicles

Would an electrically driven combat vehicle be feasible on the battlefield? Engineers at the U.S. Army Tank-Automotive Command (TACOM), Warren, MI, working with other government agencies and industry, hope to answer that question in a long-term research program to evaluate electric propulsion systems for military ground vehicles.

Such a system could be a hybrid design consisting of a diesel or gas turbine engine that would drive an electric generator. The generator, in turn, would supply power through electric cables to track-sprocket drive motors, as well as to all other vehicle electrical and electronic equipment.

Hybrid electric propulsion systems are not new; diesel-electric systems have been used successfully for many years in ships, railroad locomotives and other applications. But according to TACOM Research, Development and Engineering Center engineer Ghassan Y. Khalil, who heads the TACOM electric drive research program, advances in electronics required to develop controls for an all-electric combat vehicle have only recently made hybrid designs viable candidates for such applications.

"Electric drive demonstrators were built by TACOM in the early 1960s," said Khalil, "but the performance was limited by power controls. With the advances in technology that have resulted in electric motors and power electronics, it is now possible to build much smaller systems with higher power ratings."

TACOM expects to award a contract in FY92 for the design, fabrication and demonstration of a tracked research vehicle over a five- to six-year period. Dubbed the Electric Drive Technology Demonstrator, it will allow engineers to demonstrate state-of-the-art electric-drive technology and evaluate its potential in a combat vehicle. Specific details about the demonstrator's design, such as the type of engine, generator and drive motors to be used, has yet to be decided and will not be known until after the contract is awarded.

"This program will be an important one for us," said Khalil. "We know electric drives are feasible. But we have never at TACOM developed an electric drive, tracked combat vehicle from scratch that we could run tests on and get the data we need to substantiate claims of fuel economy and acceleration."

If adopted for Army ground vehicles, an electric drive would offer important benefits over conventional propulsion systems. An electric drive, according to Khalil, does not need a mechanical transmission behind the engine. This means there are no gears to shift. The power changes needed to meet vehicle requirements are made by changing the voltage and current to the drive motors.

Khalil said another advantage is that an electric drive has a significant amount of flexibility. "We are not restricted by shafts and gears," he noted. "We have cables and modular components. So in terms of space management, there is a great advantage, because we can put the different components in the most convenient places in the vehicle. For example, the engine and generator could be located off to one side, which would free up the other side for rear ammunition loading. Or they could be in the front or rear."

Khalil noted that an electric drive may make other changes possible that, if proven feasible, could improve the overall combat effectiveness of a vehicle. He said the most significant of these would be to replace the standard propellant-fired gun with one that uses electrical energy to fire projectiles.

There are two types of electric guns. One of these is called an electromagnetic rail or coil gun. In this concept, the projectile sits on conductors, which, when energized with a high-powered electric charge, produce an electromagnetic pulse. This pulse propels the projectile out of the gun barrel at a much higher velocity than that achieved in a conventional gun, thereby increasing its penetration.

The success of an electric gun will depend largely on the development of batteries and capacitors or inductors. He said they must be small enough to fit inside the vehicle yet capable of delivering high energy bursts needed to fire the gun. "If you would ever try to use an electric drive to power an electric gun directly," said Khalil, "you would need about 6,000 horsepower to produce the required rate of fire. This is not practical. So if we are going to have electric guns, we will need to develop the technology for batteries, capacitors or other power storage devices.

"If we were to use existing-technology batteries or capacitors to store the power needed for an electric gun," he added, "the units would be the size of a living room in a house. Obviously, this would be too big to fit in a vehicle. But research is now focused on downsizing the batteries or capacitors to about one cubic meter, and it will probably take about 10 years for industry to develop the technology to do this."

The preceding article was written by George Taylor, a technical writer-editor for the U.S. Army Tank-Automotive Command.

Army Seeking New Training Helicopter

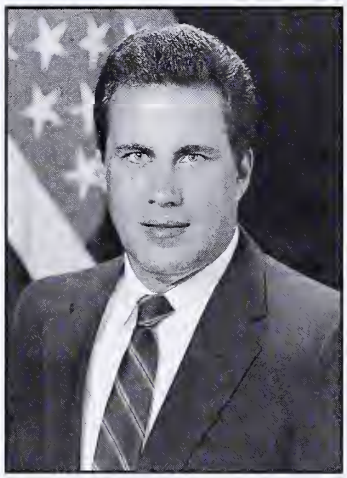
The Army is planning to acquire a new helicopter to be used in training its fledgling helicopter pilots. To meet the need for a smaller, less expensive helicopter, the U.S. Army Aviation Systems Command in St. Louis, MO, has issued a preliminary request for proposal which asks for comments on the lease of 157 to 180 "off-the-shelf" aircraft.

The lease concept is an innovative approach for providing a lower cost helicopter for the initial-entry rotary-wing training program at Fort Rucker, AL.

The Army is not seeking prices yet, but is requesting comments and suggestions on how the lease concept could work most effectively. Purchasing of the helicopters, instead of leasing, is an option still being held open by the Army.

The aging Huey, which costs about $600 per flying hour to operate, will be replaced. Not all Hueys will be replaced, only those used in the training program at Fort Rucker. The Army is searching for a commercial helicopter significantly smaller in airframe and less expensive to operate and support than the Huey. The Army plans to have the new trainer in service by FY 94.

In View of the Current DOD Build Down, What Should the Army Do to Insure it Gets the Most 'Bang For Its Buck' in Future Acquisition Programs?



The Honorable Stephen K. Conver
Assistant Secretary of the Army (RDA) and Army Acquisition Executive

For budget reasons, we have already broken the Army procurement account. We need to reverse this, even if it means reducing other accounts that we consider important. Like the training of competent soldiers and leaders, the Army modernization program can be broken irreparably. We must continue to strive for more procurement dollars. It is in the best interests of our nation to have a trained, ready and *well-equipped* Army. We need to put equipment in the hands of the soldier—that's the bottom line. If we continue on our present path with procurement funding only slightly higher than our research and development (R&D) funding, we will lack the ability to convert our research efforts into new or upgraded equipment for the soldier. R&D without procurement doesn't help the soldier at all, and in these austere times we must make every R&D and procurement dollar count.

As the total budget for acquisition declines, it is imperative that we spend our dollars wisely. While the tendency may be to start buying the same numbers of programs in significantly smaller quantities; this is precisely what we must avoid. Reducing procurement quantities increases the unit cost of each item and our procurement money will actually buy less because of the inefficiencies that are inherent in very limited production. We need to commit our limited dollars to a smaller number of critical programs, buy them in sufficient quantities, and obtain the lowest possible unit cost. That's one way to make every dollar count.

Finally, we must fund only those programs that satisfy a strong user need, are executable and approvable by the Office of the Secretary of Defense (OSD) and the Congress. We've got to make sure we can defend our programs to OSD and the Congress. Every dollar in our budget is at risk, and no program should be in our budget that can't be defended.

GEN William G.T. Tuttle
Commanding General U.S. Army Materiel Command

By definition, any system that meets the user's requirement has "Bang for Buck" value. The challenge is to accurately describe the requirement in such a way to insure that the soldier gets what he or she needs, but is not "gold plated." We do not want to buy more capability than we need. The only way to determine exactly how much is both good enough and affordable is to involve industry in the request for proposal process. Industry can help us prepare focused, reasonable, performance oriented, statements of work. Depending on the acquisition, it may be a good idea to have industry prepare this document. This insures that commercial standards are emphasized, minimizing military specifications, standards, and the amount of "paper" associated with the procurement.

With the reductions in budgets and procurement programs, we expect a greater portion of our business will be conducted with industries who have dual use (military and commercial) technologies and manufacturing processes. We, as one of several customers, can expect to pay a share of the costs of technology and manufacturing rather than the entire amount. The goal? Access to the latest in world class technology at an affordable cost, and the creation of a government-industry to aggressively manage the development of the system. The Armored Systems Modernization Common Chassis advanced technology transition demonstrator is an example of a performance oriented approach, and many of our truck programs draw extensively from the commercial automotive market for components and technology.

SPEAKING OUT

Dr. Kenneth J. Oscar
Deputy Commander for Research, Development and Engineering,
U.S. Army Tank-Automotive Command

We need to go back to basics. We are in a changing environment, so the first thing we need to do is clearly define who it is we are defending against. What is our mission? What kinds of equipment will need to be developed to defend against whom? Then, once the threat has been identified, we need to come up with some well-defined programs and stick with them—throughout the acquisition process. Such early top-down analysis and guidance would greatly streamline the current bottoms up budget planning process. In doing this, it is imperative that we challenge hardware requirements to make sure we get equipment designed to specifically meet that threat and not spend money needlessly for unnecessary weapon-system capabilities. We also need to carefully review specifications we put into procurement contracts to make sure we don't end up with nonessential paper requirements that don't buy us anything.

In addition to going back to basics, we must also empower the people! Every day, thousands of people have ideas that would reduce costs, speed the development process, and result in higher quality equipment. TACOM is creating an atmosphere of "ideas are important" by a policy of management not saying no. Employee involvement helps create an environment for continuous process improvement. Through "process action teams," we are implementing our employees' recommendations, and I am convinced that if all DOD agencies do this, it will ultimately lead to increased customer/user satisfaction.

COL John S. Caldwell Jr.
Project Manager Abrams Tank System

Over the years, the Army's leadership has streamlined the acquisition process to define and prioritize requirements. The process has served the Army well during periods of increasing budgets. However, the following actions are needed during the DOD/Army build-down.

First, the Army's very top civilian and military leaders must set clear priorities for the expenditure of RD&A funds—and rigidly bring the rest of the leaders in line. The dilemma is that senior field commanders are charged with the awesome responsibility of leading this nation's soldiers into combat to execute the National Military Strategy. Therefore, these senior commanders will always have legitimate resource requirements that exceed the Army's budget—and, in fact, are nearly independent of the budget. However, the current "bottoms up" system to rationalize and prioritize requirements generates well motivated but bitter internal battles that are lengthy, inefficient, often inconclusive and unaffordable when budgets are declining.

Second, the Army's top leadership must ensure the military officers in critical acquisition duty positions are firmly grounded in the operational doctrine and tactics of the fighting forces. There are many other qualifications these officers need, but without this "operational savvy" PEOs, project managers and others cannot communicate effectively with their customers—the field commanders. Further, they will not be able to effectively translate the field commanders' requirements into lethal, survivable, supportable equipment.

BOOK REVIEWS

Defense Acquisition Management

By George Sammet Jr. and David E. Green
Florida Atlantic University

Press Reviewed by MAJ Jack A. Oliva, the special projects officer for the deputy commanding general for research, development and acquisition, U.S. Army Materiel Command.

Defense Acquisition Management by Sammet and Green condenses the vast world of acquisition management into a comprehensible form. The book is particularly noteworthy because each issue is presented from both the military and the civilian contractor perspectives.

This balanced view is possible because of the unique qualifications of the authors. Both were accomplished acquisition managers in the Army and have extensive experience as executives in the defense industry. GEN George Sammet (retired) is a former commander of the

Army Materiel Command and is currently a vice president for Martin Marietta corporation. COL David E. Green (retired), recently retired as director of procurement operations for Martin Marietta Aerospace, served as the U.S. Army program manager for the Stinger missile system. Their long careers in both the military and industrial side of the process have allowed them to present a very balanced view.

The book is an excellent source of information for anyone who is trying to understand how defense acquisition is managed. It begins with a 28-page introduction that walks even the most uninitiated reader through understanding the process at macro level. The subsequent chapters go into greater detail on every aspect, participant and subsystem that make up the acquisition system. This format allows the reader to see the big picture and then focus on the parts of the system in manageable pieces.

Sammet and Green analyze each piece of the process to include the historical development that has brought us to where we are today. Of course, acquisition management is a dynamic process and this book (as any) is locked in time. Even though, eventually, this book will become dated its thoroughness and readability will make it a milestone work that will be consulted by others in the future as they chronicle the development of the process.

There are several groups of people who will benefit by reading this book. It is a "must" for anyone working in the government side of acquisition. For those in industry contemplating marketing their products to the Department of Defense it contains an appendix titled "How to Prepare a Winning Proposal." Additionally, anyone interested in studying the evolution of complex systems, management or the interaction of government with the private sector will find this a rewarding study.

The book relies heavily on the aerospace industry for examples, undoubtedly due to the authors' experience in that area. It is filled with thought-provoking graphs and analyses. Although one could question how different segments of the defense industry would compare with the examples given, the aerospace industry provides a good vehicle for the discussion of topics presented.

Sammet and Green have provided a comprehensive, readable analysis of one of the most complex systems in our government. This book will contribute to a better understanding of that system by all its participants and observers. It will likely be an important source document for future research and analysis of the topic.

Government Printing Office Releases Publications

The following books are available from the U.S. Government Printing Office:

Close Air Support by Benjamin Franklin Cooling
Edition: 1990
Stock Number: 008-070-00635-9
Synopsis: This book examines the development of various doctrines on the application of aviation against battlefield targets. Since the introduction of aircraft to warfare, ground commanders have seen them as a powerful addition to their plans for dislodging and pursuing an enemy or for defending against assaults on friendly positions.

Recurring Logistic Problems As I Have Observed Them by Carter B. Magruder, General, U.S. Army Retired
Edition: 1991
Stock Number: 008-029-00209-4
Synopsis: The study of the logistical aspects of war is of particular importance in our peacetime Army because, as General Carter B. Magruder so forcibly reminds us, basic problems tend to recur in logistics. Despite the radical transformation in equipment and supplies that distinguish today's Army from the one Magruder entered in 1917, the principles that guided the technical services of his day apply equally to those who serve in combat service support assignments in 1989.

National Defense University by Jeffrey Simon
Edition: 1991
Stock Number: 008-020-01229-7
Synopsis: Just as the French Revolution in 1789 changed the face of Europe, the revolutions of 1989 ended the Cold War and collapsed the old security relationships. Nothing less than a new European security order is in the offing. While the final form of this new order remains unclear, a few elements are evident. First, Europe is moving from a highly stable environment to one that is unstable. Second, European insecurities are likely to increase, thereby making the challenges to security different from those of the Cold War era.

Individuals who would like more information on any of these books can contact Mr. Thompson, U.S. Government Printing Office, Dept. SSMC, Washington, D.C. 20401; Telephone (202) 275-3340.

BOOK REVIEWS

If you have read a book which you feel may be of special interest to the RD&A community, please contact us. The editorial staff welcomes your literary recommendations. Book reviews should be no longer than two double-spaced typed pages. In addition, please note the complete title of the book, the author's name, address, and commercial and DSN phone numbers. Submit book reviews to the address below.

Army RD&A Bulletin
ATTN: SARD-AC
5001 Eisenhower Avenue
Alexandria, VA 22333-0001
Phone: (703) 274-8977/8
DSN: 284-8977 Fax:(703) 274-8038

ARMY
Research
Development
Acquisition
RD&A
BULLETIN
Professional Bulletin of the RD&A Community

WRITER'S GUIDELINES

ABOUT THE BULLETIN: Army RD&A Bulletin is a bimonthly professional development bulletin published by the Army Acquisition Corps Proponent Office, an element of the Office of the Assistant Secretary of the Army (Research, Development and Acquisition). The Bulletin's editorial office is located at 5001 Eisenhower Avenue, Alexandria, VA 22333-0001. Phone numbers are Commercial (703) 274-8977/8 or DSN 284-8977. Datafax (703) 274-8038.

PURPOSE: To instruct members of the RD&A community relative to RD&A processes, procedures, techniques and management philosophy and to disseminate other information pertinent to the professional development of the RD&A community.

SUBJECT MATTER: Subjects of articles may include, but may not be necessarily limited to, policy guidance, program accomplishments, state-of-the-art technology/systems developments, career management information, and management philosophy/techniques. Acronyms should be kept to an absolute minimum and when used, must be written out and explained. Also of interest are book reviews related to Army, DOD, or pertinent industry RD&A efforts.

LENGTH OF ARTICLES: Articles should be approximately 1,500 to 1,800 words in length. This equates to 8-9 double-spaced typed pages, using a 20-line page.

PHOTOS: Include any photographs or illustrations which complement the article. Black and white or color are acceptable. We cannot promise to use all photos or illustrations and they are normally not returned unless requested.

BIOGRAPHICAL SKETCH: Include a short biographical sketch of the author/s. This should include the author's educational background and current position.

CLEARANCE: All articles must be cleared by the author's security/OPSEC office and public affairs office prior to submission. The cover letter accompanying the article must state that these clearances have been obtained and that the article has command approval for open publication.

Authors should include their address and office phone number (DSN/autovon and commercial) and commercial fax number, when articles are submitted.

Articles should be submitted on a 5 1/4 inch disk in ASCII format along with a typewritten copy. Please do not send a high-density disk.

Army RD&A Bulletin
ATTN: SARD-AC (Room 2N32)
5001 Eisenhower Avenue
Alexandria, VA 22333-0001

Commercial: (703) 274-8977/8 DSN: 284-8977
Datafax: (703) 274-8038

1991 Index of Articles

This index is a headline listing of major articles published in the *Army RD&A Bulletin* during 1991.

JANUARY-FEBRUARY

- Leadership Dimensions for Success in Army R&D
- Desert Testing at Yuma Proving Ground
- Focusing on the Customer at the Natick RD&E Center
- Expo Showcases Technology as Deterrence
- The Component Advanced Technology Test Bed
- The Strategic Logistic Program
- PEO Feature—Communication Systems
- Electronic Warfare Vulnerability Assessment Program
- Army's AIM Effort Helps Streamline Acquisition
- Adhesive Bonding Workshops
- Titanium May Hold Key to Lighter Combat Vehicles

MARCH-APRIL

- Advanced Technology Transition Demonstrations
- New Findings on the Health of the Force
- Unmanned Aerial Vehicles
- Army Announces R&D Achievement Award Recipients
- What AMC-FAST Can Do For You
- Army Research Office: Shaping the Future Through Basic Research
- The Three Graces of Force Modernization
- PM Feature—The Light Helicopter Program
- U.S. Army Aviation Systems Command
- Laser Protection of Telescopic Optics
- New PM Combines Instrumentation, Targets, Threat Simulators
- Form, Fit, Function Documentation
- ALON Material Slated for Missile Use

MAY-JUNE

- AMC RD&A Support for Operation Desert Storm
- HEL and the Patriot Air Defense System
- TACOM Solved Hot Exhaust Problem for Desert Troops
- Medical R&D Contributions to Operation Desert Storm
- Corps of Engineers R&D Support for Operation Desert Storm
- Remote Sensing of the Persian Gulf Oil Spill
- Topographic Engineer Technology ... Vital in Desert Storm
- Lessons Learned in Fielding Research Knowledge
- Army Research Office: Shaping the Future Through Physics and Chemistry

JULY-AUGUST

- Army R&D: 50 Years of Achievement
- Large Area Smoke Technology
- The History of Desert Testing
- U.S. and Canada Large Caliber Ammunition Exchange Program
- Deploying the Voice of the Customer with Total Quality Design
- PEO Feature—Air Defense
- Commander—U.S. Army Missile Command
- Nuclear Hardening of Army Systems
- A Necessity for Resource Allocation Decisions
- The 'Rapid' Way to Software Development
- Testing of the M109 Series Howitzer

SEPTEMBER-OCTOBER

- Army Laboratory Restructuring and Enhancement Plans
- Army Research Office: Shaping the Future Through Mathematics
- Interview with LTG August M. Cianciolo, Director of Acquisition Career Management
- Concept Engineering
- The Long Arm of Soviet Artillery
- Developing Management Strategies for RD&A Programs
- A New Tool for the Combat Developer
- PEO Feature—Aviation
- Dental Imaging System: A Dream Come True
- The Marriage of Technology and Doctrine—Evolution of the Air Assault Concept
- Expert Systems at the Ordnance Missile and Munitions Center
- CECOM Develops Firefinder Software

NOVEMBER-DECEMBER

- Military Lessons Learned from the Gulf War
- Physical Security Equipment Management
- Technology Transfer—It's the Law
- ETDL Inventor Receives $10,000 from Patent Fees
- Environmental Clean-up of Explosives Contaminated Soils
- The Army Center of Excellence for Advanced Propulsion Systems Research
- Implementing the In-Plant Quality Evaluation Process
- Chemical Weapons Treaty Verification
- U.S. Army TACOM and Tank-Automotive Research, Development and Engineering Center Feature
- The Army Industrial Modernization Incentives Program
- Innovative Operational Testing
- Therapy in HIV Patients Using Recombinant GP160 Vaccine
- Application of Level of Repair Analysis
- TACOM Develops M1 Mine Clearing Robot

☆U.S. GOVERNMENT PRINTING OFFICE: 1992—311-809/40003

FROM THE ARMY ACQUISITION EXECUTIVE...

During the 22 months I have been the AAE, I've given a lot of thought to what we in Army acquisition are doing to equip the soldier, which is our solemn responsibility. How are we meeting this obligation? What is our goal?

I recently spoke to the U.S. Army War College Class of 1992 on the Army's role in research, development and acquisition as part of their study on "Equipping the Force." There was great interest in Army modernization among the students and the questions asked of me were thought provoking. One, in particular, I found intriguing: "Are there ethical considerations in equipping the force?" Yes, I said, there most assuredly are ethical considerations involved in equipping the force. These ethical considerations go beyond personal integrity and involve a moral obligation to our soldiers to make certain that they are properly equipped to fulfill their missions.

Careful thought and lively discussion of our acquisition responsibilities have helped to shape my vision of a clear-cut *goal for Army modernization.* That goal is *to provide our soldiers with world class equipment in sufficient quantity and in the shortest possible time, consistent with sound business practices and within affordability constraints.* We must have an Army that is trained, ready, and well-equipped.

Because the goal is a mouthful, let me explain each of its components. We seek *"world class" equipment* (rather than "best possible" equipment) because the latter may imply that we are "gold plating" and spending our limited funds inefficiently. We don't want to do that. Second, if we intend to procure an item of equipment, we should buy it in *sufficient quantity* (or not at all). Buying in limited quantity invariably means high program unit costs and partial fielding of our force. *Shortest possible time* suggests that we can't afford to take 10 or 15 years to get new capabilities in the field; we need to do it as quickly as prudently possible. However, I hasten to add that we need to do this *consistent with sound business practices* because if we try to rush a program through by having an unreasonable schedule requirement, experience shows that it ends up taking longer and costing more. Finally, we have the concept of *affordability constraints.* I do not expect the Secretary and the Chief to give the acquisition community an open checkbook and let us buy everything we want. There are serious financial constraints in this business, but I think we have to work within the limitations and get the most for the soldier out of every dollar that we spend on equipping the force.

I believe there are three sets of principles that will guide us as we strive to reach our goal for Army modernization. I describe them this way:

- **Modernization strategy.** *Why* is modernization important and what should be *our general approach* to equipping the Army?
- **Resource allocation strategy.** *What* should we buy to support our modernization strategy?
- **Acquisition strategy.** *How* should we execute the modernization programs and the dollars entrusted to us to get the most benefit for the soldier for each dollar spent?

All of these strategies merit a lengthy discussion, and I intend to cover each of them thoroughly in upcoming articles. While we are making progress, the debate on Army modernization must continue. High quality modern equipment is as vital to the performance of the soldier as training, leadership, doctrine, and force structure. Each of these imperatives contributes significantly to a Total *Quality* Force.

Therefore, our modernization goal should not, as some suggest, be limited to killing flawed programs or avoiding acquisition fiascos like Sergeant York or the Aquila. Nor is our goal focused on eliminating program risk. Finally, it is not our goal just to advance the state-of-the-art in our technology. Each of these factors—preventing fiascos, managing risk, and improving technology—is just a *means* to the important end of equipping the American soldier.

Steven K. Conver

ARMY RD&A BULLETIN
ISSN 0892-8657

Army RD&A Bulletin
5001 Eisenhower Avenue
Alexandria, VA 22333-0001

SECOND CLASS
POSTAGE PAID
AT ALEXANDRIA, VA
(and Additional Offices)